November 1942

TECHNOLOGY REVIEW

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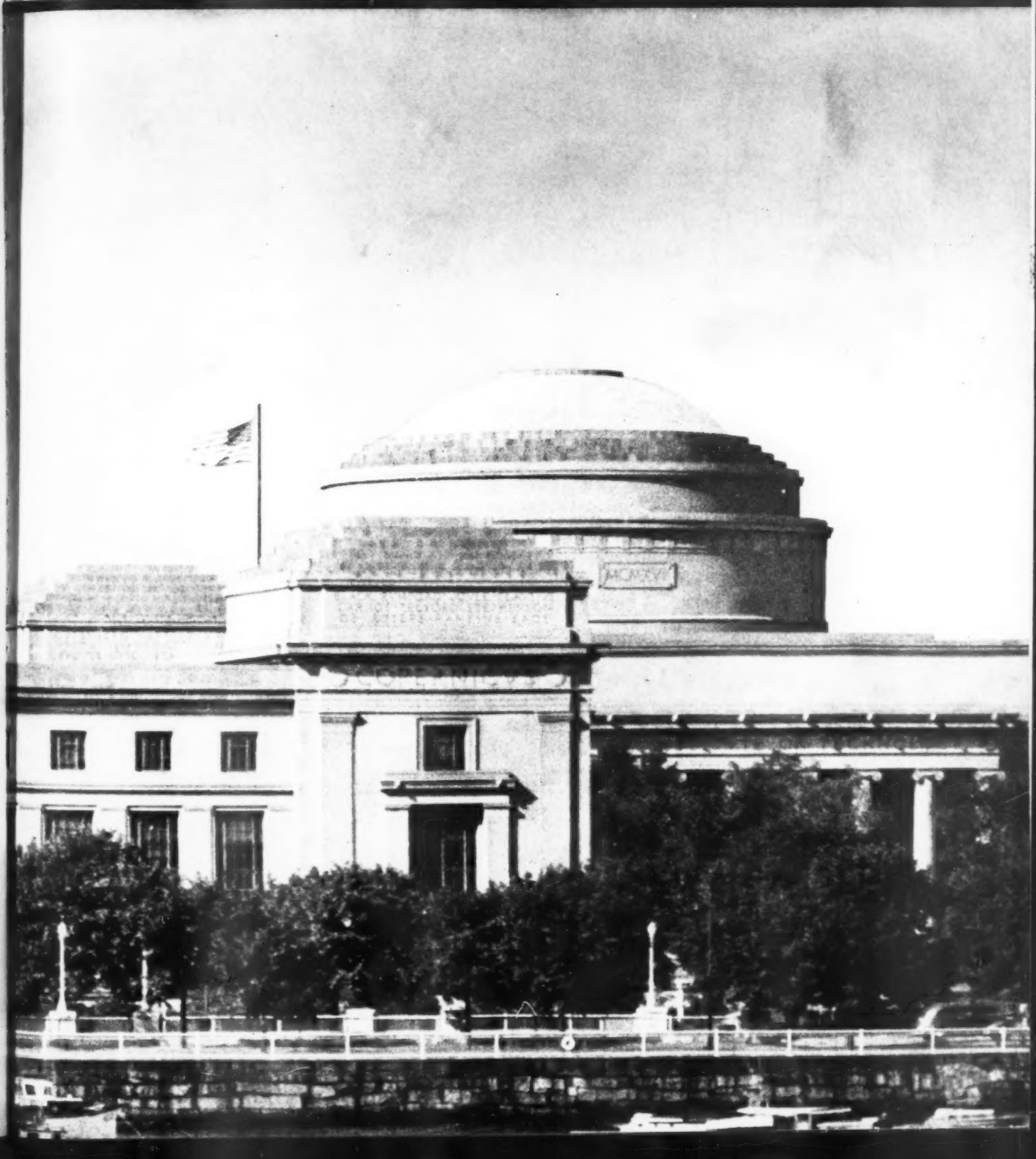

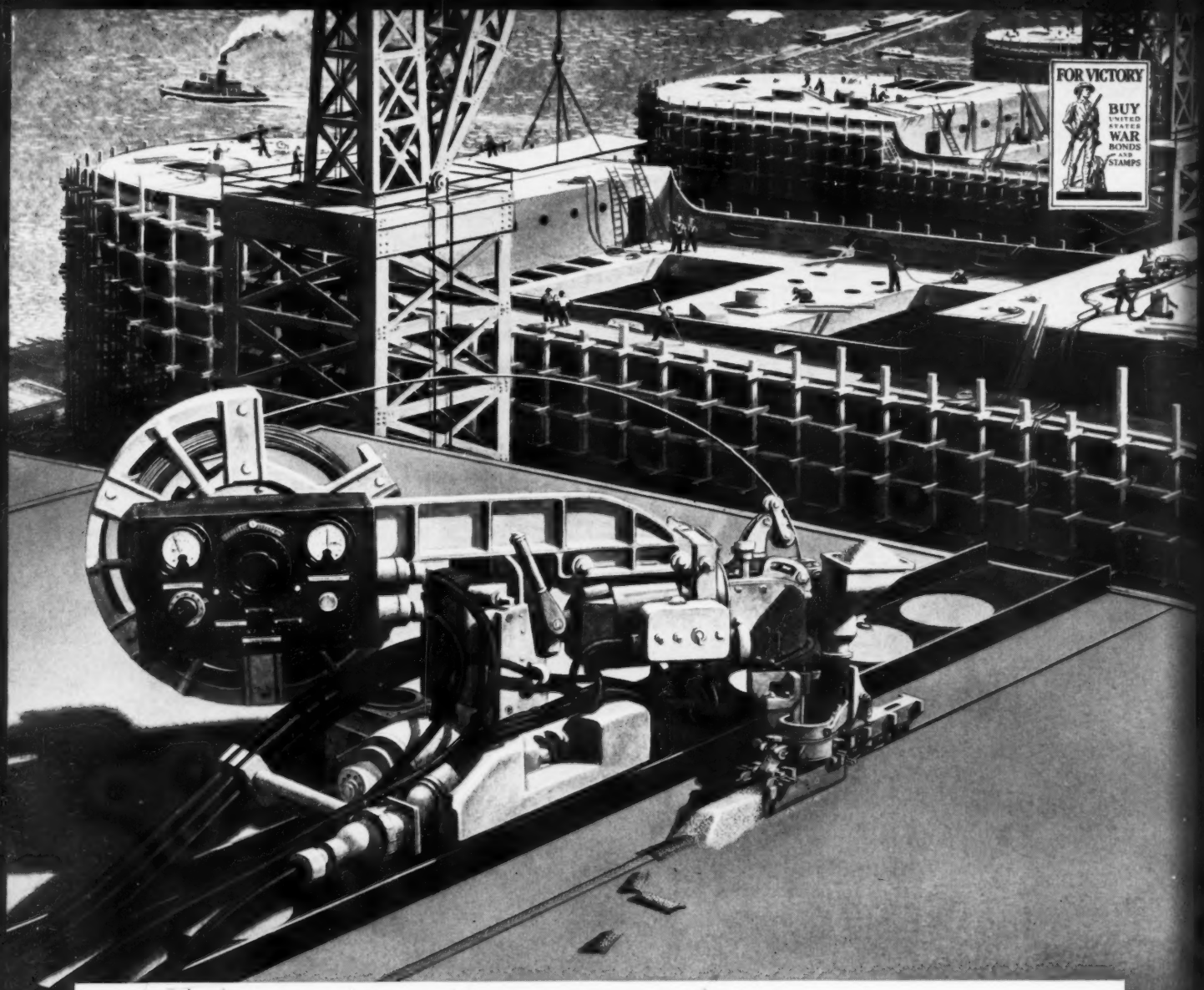

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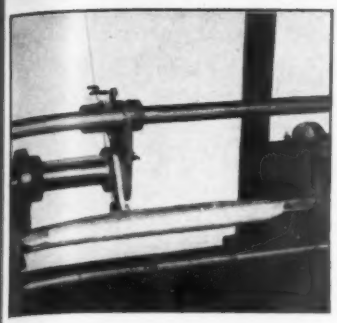

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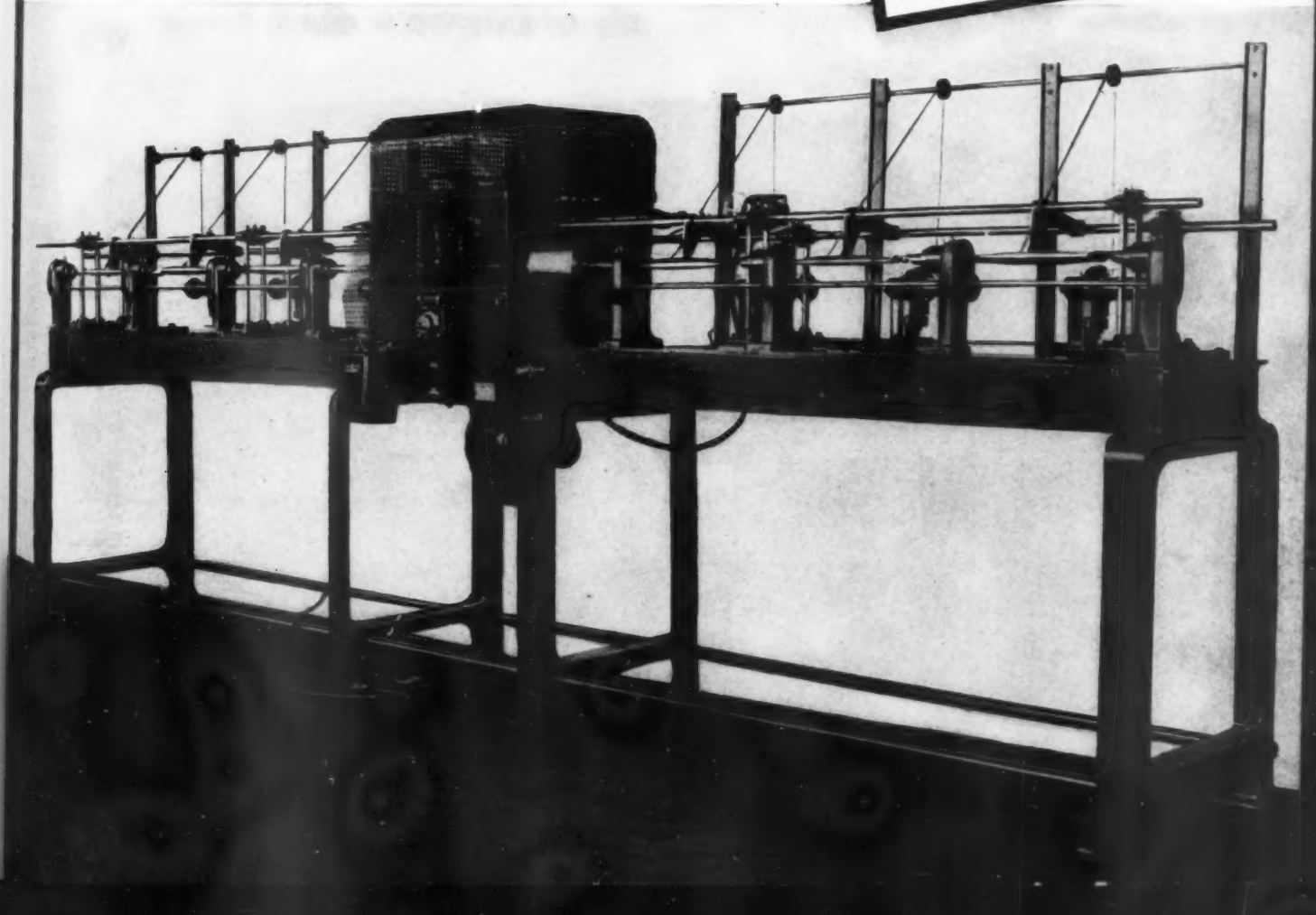

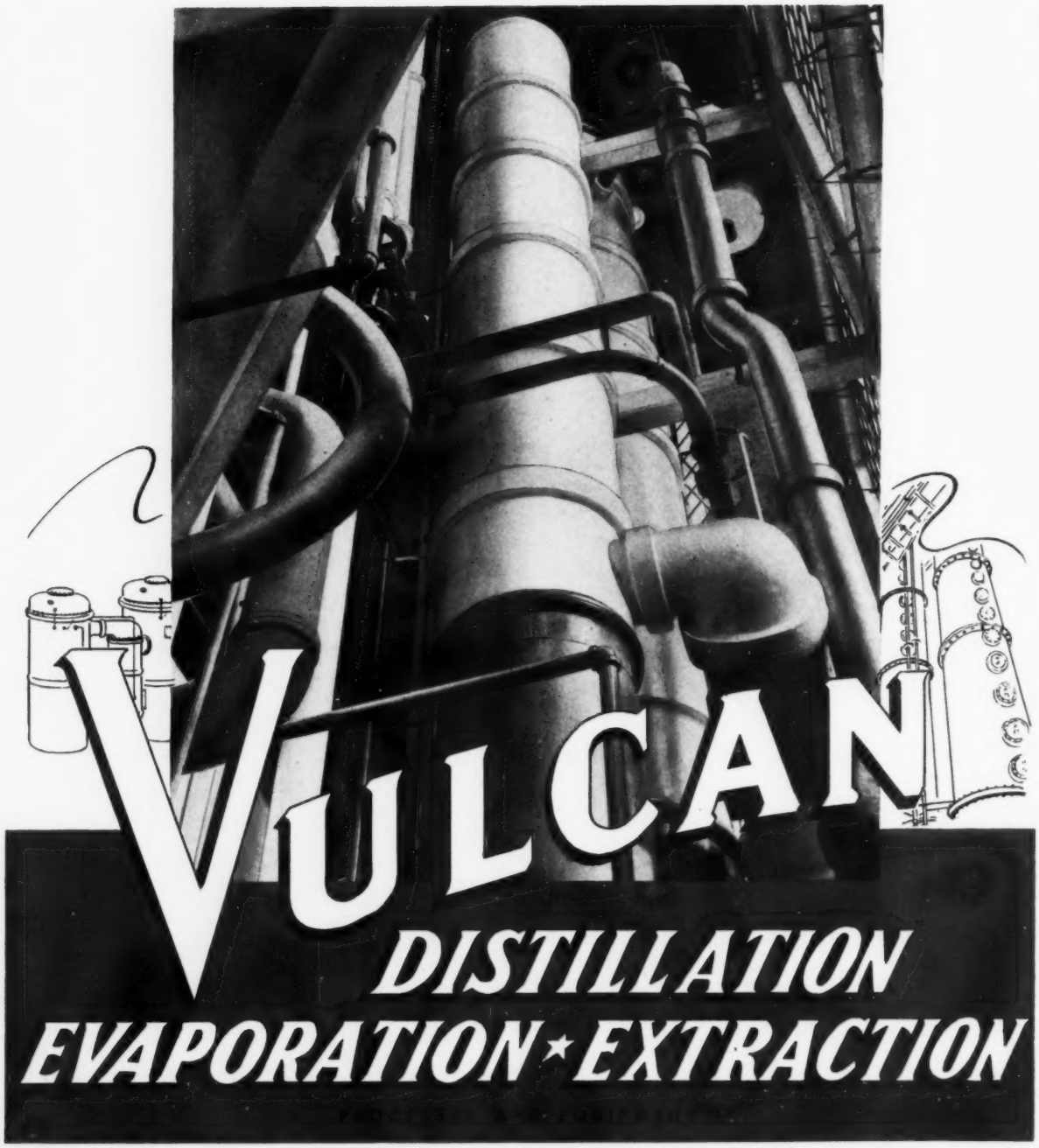

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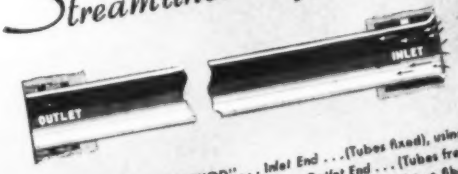

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THE TABULAR VIEW

War. — As our cover photograph suggests, Technology's performance of its responsibilities as an American institution bulks large in this first issue of The Review, Volume XLV. From PRESIDENT KARL T. COMPTON we present two discussions which constitute a well-rounded picture of the Institute in these days of trial. The mood and spirit in which the Institute community is doing its work speak in his address of welcome to incoming students this fall (page 17); the great extent and import of that work are surveyed in excerpts from his annual report to the Corporation (page 31). Implicit in both discussions is the fine and unassuming quality of his own leadership, which is a constant source of strength to the whole Institute in extraordinary times.

Amity. — As adviser on Latin America to the State Department and to the Coordinator of Inter-American Affairs and as a diplomatist of long experience, ROBERT G. CALDWELL, Dean of Humanities at Technology, writes with authority (page 19) of the importance of maintenance of cultural relations between nations in time of war. Dean Caldwell's article argues powerfully for the long-range view.

Formulation. — Among the more stimulating contemporary thinkers on matters aesthetic is AMÉDÉE OZENFANT, from whose *Foundations of Modern Art* The Review for November, 1940, quoted. In the present issue, M. Ozenfant discusses (page 22) a theory of the origin of art forms which is wide ranging in its philosophical substance. Born in Picardy in 1886, his father a builder and his mother a porcelain painter, M. Ozenfant after a brief interval at the Beaux-Arts studied painting in the Académie La Palette with other Moderns. First as a Cubist and then as a Purist he has sought directness of appeal in art. His paintings are in museums and private collections from Moscow to Chicago.

Native. — Steamboats built for navigation of American rivers and sounds in the first half of the Nineteenth Century contributed greatly to creating the American tradition. Their history as a story of mechanical advance and of human interest is recounted in this Review (page 25) by W. MACK ANGAS, '17, Captain, Civil Engineer Corps, United States Navy, who is already well known to Review readers.

Control. — Some of the remarkable progress made in regulating the optical properties of glass — particularly its ability to transmit and to bend radiation — is described for The Review (page 28) by HAROLD R. MOULTON, assistant research director of the laboratories of the American Optical Company.

Invention. — A note on the construction of a native bridge in war-torn New Guinea is contributed (page 14) by M. F. ASHLEY MONTAGU, associate professor of anatomy, the Hahnemann Medical College and Hospital of Philadelphia, frequent and provocative writer on physical and cultural anthropology.

Information supplied by "Mechanical Engineering"

There exists a very evident need for the correlation of available data on mechanical springs, and for the formulation of a standard code for the design of helical springs. As a result, a group of specialists have made suggestions in a symposium, published in the July 1942 Transactions of the A.S.M.E. which it is hoped will crystallize into early action.

The scope of a proposed code, design stresses, the arrangement and scope of helical spring tables, the advantages and disadvantages of nomographic charts, and the future research needed on mechanical spring problems are all discussed in the symposium.

Serious attention to the problem of mechanical spring design began in 1924 with the establishment of the A.S.M.E. Research Committee on Mechanical Springs. Since that date, 66 papers on the subject have appeared in various A.S.M.E. publications. They have laid the groundwork for a design code which, when completed and adopted, should simplify the work of designers. The symposium contains a bibliography.

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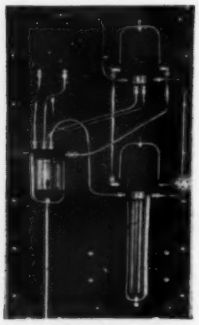

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For Intelligent Censorship

FROM CHARLES H. BLAKE, '25:

We have been engaged for many months, whether we believe it or not, in total war, and still it seems necessary to emphasize this point repeatedly. To a large extent our failure to accept the idea of total war arises partly from ignorance of the definition of the concept and partly from humanitarian considerations. Not only must we attack all military personnel and installations of the enemy by every possible military means but we must attack the whole enemy population by all possible effective means, military and nonmilitary. It is precisely this last aspect of total war which is so abhorrent to democratic peoples.

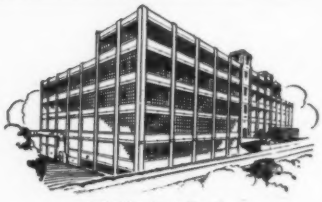
We do not, of course, have to adopt all of our enemies' less amiable methods of warfare, but we do have to remember that ultimately our problem is to put out of action the largest number of enemy effectives and that the effectives in modern war include virtually all civilians. It must by no means be forgotten that the majority of the German people, nazi or not, hoped to profit from the program of the Nazis. They may not have approved of nazi activities inside Germany, but they certainly approved on the whole of the external policy and the methods of carrying it out.

One aspect of this total war has been brought into the open by a recent discussion in the pages of *Science* on the propriety of suppressing technical information of medical and sanitary significance. The committee on medical research of the Office of Scientific Research and Development seems to feel that we should take a humanitarian point of view and not suppress such facts. On the other hand, the technical data license division of the Board of Economic Warfare has undertaken to censor certain findings which appear to be chiefly of medical significance. The issue is clearly joined, but the view held by each group is somewhat restricted.

For example, a nonpoisonous lining for lead tooth-paste tubes may have purely medical or humanitarian value. On the other hand, it is by no means certain that such knowledge could not be applied in other fields where its value might be clearly industrial and military. P. W. Bridgman saw this plainly when he closed his laboratory to citizens of totalitarian powers. Examples need not be multiplied. We need only remember that our enemies take the attitude that justice and fair dealing are only for one's own people and that whoever is not on their side is *ipso facto* against them.

Any medical discovery of ours which may come to the knowledge of the Axis will be used not for the general benefit of all peoples under their control but only for those segments of (*Concluded on page 54*)

Speed with Economy



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When Uncle Sam stopped the manufacture of cars for general use, he did more than change the greatest automobile plants in the world into arsenals for tanks and planes. He also released the giant facilities of the spark plug manufacturers for the making of war materials. But in giving these firms new things to make and new alloys to make them of, he handed them new problems with every sheaf of blueprints.

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The Revere Technical Advisory Service functions in (1) developing new and better Revere materials to meet active or anticipated demands; (2) supplying specific and detailed knowledge of the properties of engineering and construction materials; (3) continuously observing developments of science and engineering for their utilization in production methods and equipment; (4) helping industrial executives make use of data thus developed. This service is available to you, free.

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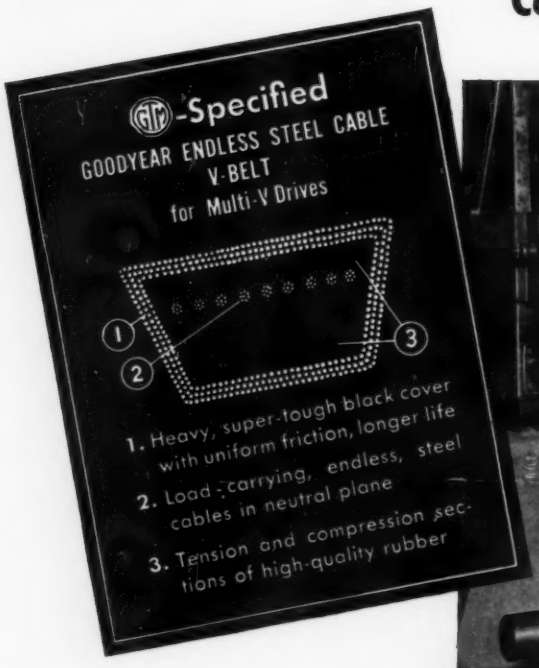

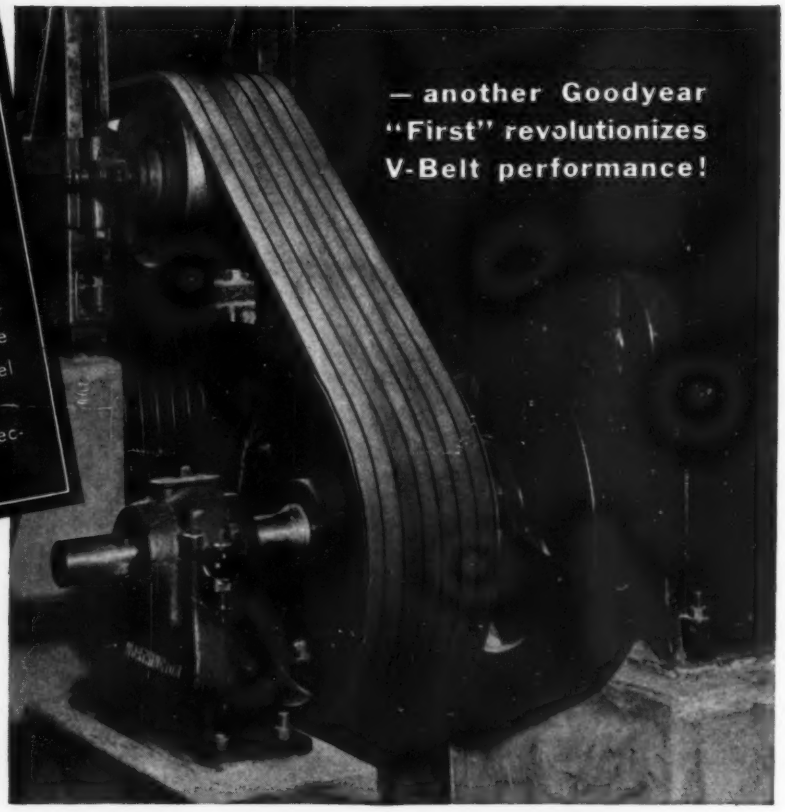

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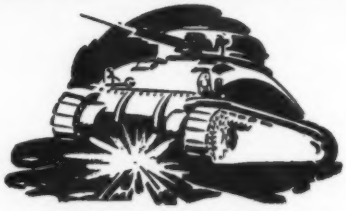

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VOLUME 45 NUMBER 1

THE TECHNOLOGY REVIEW

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EDITED

AT THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

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G. H. Voaden

Whirling light — the experimental wind turbine on Grandpa's Knob in Vermont photographed by night, with star streaks registering through and the shadows of cables registering on the speeding blades

THE
TECHNOLOGY
REVIEW

Vol. 45, No. 1

November, 1942

The Trend of Affairs

Pisciculture

FOR southern farmers with cotton fields so exhausted as to prevent the raising of any ordinary crop at a profit, the Alabama Agricultural Experiment Station at Auburn, Ala., recommends fish farming. The main essential is a field so situated near a stream that it can be dammed off and converted into a pond without too much expense. The erstwhile field is then stocked with fish appropriate to the climate and conditions, particularly bass, catfish, and bream. Fertilizers of the usual commercial varieties are added to encourage the growth of aquatic plants on which microscopic animal life feeds. These plants, after a few transformations, support the fish which eventually grace the farmer's table or which go to market as a cash crop. Compared with the 150 pounds of beef which can be raised on an acre of the quality suggested for conversion to fish ponds, as much as 600 pounds of fish are claimed, and the production cost per pound is considerably lower than that of beef. Better than 400 pounds an acre have been obtained from German fish farms.

Behind this idea is a long history of successful fish culture. Trout were first raised artificially in this country in 1864, and since then a fair-sized pondfish and goldfish industry has also been developed. In 1928, breeders sold 21,500,000 goldfish valued at almost a million dollars; most of them were distributed through five-and-ten-cent stores. Food for the fish is an important cost in production, and it is therefore interesting that in one German fish farm the outlay for this item before the war was zero. Effluent from the sewage-treatment plant at Munich, a city of about 750,000 persons, then was fed to fish ponds after dilution with fresh water. Since such effluent still contains particles of organic matter which are broken up by bacterial action, the basis is formed for an ecology in which carp and rainbow trout are the final elements. These are sold when they are three to four years old and weigh about 3½ pounds each. In 1933, some 125 tons of fish were sold.

A most important branch of pisciculture is oyster farming. It is indeed more like farming than fishing: The eggs are raised to seed oysters, the seed oysters are planted on beds which are sometimes specially prepared, they are often transplanted to locations where they will grow better, pests and enemies are kept down, and finally the crop is raked from the bottom. About half the oyster crop of the United States comes from private oyster farms, and many of the public beds are aided by state or Federal efforts.

The Bureau of Fisheries is by far the greatest pisciculturist in the world. In the fiscal year of 1940 the output of eggs, fry (young fish), and adult fish from the 104 Federal fish hatcheries in operation during that year numbered over seven billion, not a record. While some 45 species of fishes were handled, most of them fresh-water varieties, the largest part of the production was four salt-water species — cod, haddock, pollack, and (taking a broad view of the word "fish") lobster. With the assistance of commercial fishermen who gathered, fertilized, and planted eggs on the fishing grounds, the bureau distributed over a billion haddock eggs and almost three billion cod eggs and fry on selected grounds.

Nevertheless, these efforts are probably only supplemental at best to nature's ways of maintaining the stock of these fish. The hatcheries are of greatest relative importance to fresh-water and migratory fishes. The conception that fish are enormously prolific may be in order for the common commercial sea fishes, but it does not apply to such fishes as the salmon and trout. Compared to the 4,500,000 eggs which a cod may yield, Chinook salmon produce an average of 4,900 eggs apiece; steelhead, an average of 5,300. Under natural conditions, perhaps 95 per cent of the salmon hatched in the head-

This picture of a native bridge demonstrating independent invention of types of construction is reproduced from an illustration in The Land That Time Forgot, *by Michael Leahy and Maurice Crain, by permission of Funk and Wagnalls, the publishers. The original of this and other photographs, sent to England to be used in an English edition of the book, were destroyed during the bombing of London.*

waters of Pacific streams never reach the sea. If reared for three months, perhaps three-quarters of them will perish; if reared for nine months, more than half will survive to begin their sea cycle.

For the migratory fishes as for many strictly fresh-water fishes, the struggle for existence has been gravely intensified by the results of man's activities — by changes in the flow and character of streams through erosion and deforestation, and by the blocking of streams with dams. Fishing for sport is also an increasingly popular pastime, it being estimated that in the 1938–1939 season more than 12,000,000 people took line in hand with intent to catch a fish. The spread of this sport has pretty well broken down the distinction between game and food fishes. With the exception of lobster, herring, whitefish, and some Pacific salmon, amateur fishermen will go after almost anything capable of underwater navigation. The result in some of the more heavily populated states is that virtually every fish caught in their streams is of hatchery origin.

An outstanding example of the government's attempts to compensate for the increasingly artificial environment forced on fishes in fresh-water streams is now under way in the Pacific Northwest, where many feel that important salmon fisheries are seriously endangered by the vast hydroelectric projects on the Columbia River and its tributaries. By an almost unerring instinct the salmon, after it has matured at sea, will always return to the stream where it spent its very early life (although not necessarily where it was born). To make up for the losses from streams to which passageway is now impossible by reason of great concrete barriers, an attempt is being made to establish salmon in streams where they have never been or where they have diminished in numbers. Fish ladders and elevators seem adequate solutions for many of the smaller dams, but the efficacy of those at the Bonneville Dam is still to be proved and the building of fish ladders for the immense Grand Coulee appears impractical. An extensive program has therefore been undertaken to breed and transplant migratory fishes. Its size may be indicated by the fact that in order to insure an adequate supply of cold water at one hatchery during the late summer, a 2,500-foot tunnel was driven through a spur of the Cascade Mountains to tap a lake 150 feet below its surface.

Independent Invention

BY M. F. ASHLEY MONTAGU

UNEQUIVOCAL proof of the independent invention of the same process or artifact by different peoples is extremely difficult to obtain. The invention of the symbol for zero by the Indians on the one hand and the Arabs on the other is sometimes cited as an example of independent invention, but one cannot be quite certain even in so apparently clear a case as this. It is therefore of interest to be able to report what is almost certainly a clear case of independent invention.

While exploring in central New Guinea during the year 1930, Michael Leahy came upon a native bridge which in its construction combined the principles of the cantilever and suspension bridge. A photograph of this bridge, which crosses the Gauil River, is here reproduced from Mr. Leahy's book, written in collaboration with Maurice Crain, *The Land That Time Forgot*. Since no white man had ever before been in this part of New Guinea and since the natives must have been isolated here for many centuries, these New Guinea natives beyond doubt invented the cantilever-suspension bridge independently. Their invention of the bridge may possibly have preceded by many centuries the European invention of it.

Unfortunately Mr. Leahy nowhere in his text refers to the bridge, but from the photograph it appears to have been built of vegetable fiber suspended on lianas attached to tall narrow tree trunks which have been sunk in the ground on either side of the river. The bridge would seem to be some 40 feet long. At least a dozen natives can be discerned crossing it, while one native with a pack on his back may be seen on land.

In the chronicles of the applied science of primitive peoples, a bridge of this type has not previously been recorded. The construction of it exhibits a grasp of engineering principles which must command the greatest admiration.

The Spinning Spindle

ROUND and round it goes, and where it stops nobody knows! This now familiar phrase is not alone applicable to radio programs. The textile whirligig swings around to the old-time hand spinning and weaving in a highly mechanized and modern England. As a morale builder and as a means of amplifying the critical civilian supply of fabrics, the rebirth of the cottage industry is proving increasingly important in Britain. Hand looms are to be found in growing numbers, and spinning wheels are again popular. These handcraft implements, almost eliminated by the growth of the machine age in the last century, are being brought back into important service for a nation totally involved in a mechanized war.

The wheel of fortune takes from Japan its wool and cotton supply and from us the product of the silkworm. The Japanese use an extra-large silk crop for substitution in the manufacture of materials ordinarily made of wool and cotton, while we, minus our usual silk supply, are using other fibers to substitute for it. By reason of scarcity of natural fibers we substitute soybean or milk proteins in the newly developed prolons. We build up molecules into synthons such as nylon and vinyon. Nylon, in large quantity, is going into parachutes and parachute shroudlines to keep our fighting men alive that milady may eventually return to her lost luxury — the wearing of nylon hose. Vinyon is being substituted for silk dental floss that we may efficiently get our teeth into the war effort.

The kapok once imported from Java and used because of its buoyancy may be replaced by filaments of rayon which look like strings of miniature beads — each bead an air-filled bubble. "Bubblfil" has desirable insulating properties against heat loss and can be bonded into a mass similar in properties to sponge rubber. Woolly sheepskins, known as shearlings, are replaceable by pile-fabric substitutes, and staple rayon of all sorts is being blended with wool for many uses.

Important as man is and as he feels himself to be through his mastery of mechanisms, his dependence upon plant, sheep, and worm once again is brought home to him as war follows war.

Lac Lacks

FEWER phonograph records are available this fall, because of wartime hazards interposed between American manufacturers and millions of minute insects in central India. Writing in *Foreign Commerce Weekly*, Donald D. Crone describes the gathering and processing of the lac crop by thousands of native cultivators who have been aided by American and English chemical research as well as by their own government in the greater development of the industry. The lac insect, *Laccifer lacca*, a fortieth of an inch long at the start of its life, transforms the juices of host trees into a red or orange secretion which, refined and washed, becomes the shellac of commerce. Laccifer grows to a twenty-seventh of an inch in length before, for the female of the species, the secreted resin which at first serves as a protection against predatory enemies becomes a cemetery for its producer.

Hotchpotch

SALVAGE of 100,000,000 pounds of essential chemicals during the next 18 months is foreseen by the War Production Board after a survey of 350 chemical industrial firms. Backing up the extensive research programs being carried on by chemical manufacturers, a campaign for the recovery of wasted materials in such operations as painting is expected to go far in assisting American manufacturers to meet the unusual demands imposed by war. Some 46,000,000 pounds of pigments, it is esti-

By way of contrast, the West Bay crossing, San Francisco–Oakland Bay Bridge. It has two main spans each 2,310 feet in length; four side spans 1,160 feet each; and an approach span 863 feet. Total cost of the structure, opened to traffic in 1936, was over $70,000,000.

DETROIT PUBLIC LIBRARY

mated, will be saved, in part through salvage of paint sludge produced by overspray. About 4,000,000 pounds of glycerin, as well as considerable amounts of oils, resins, and cellulose, are among the chemical products which will be recovered. ¶ Where traffic noises interfere seriously with the efficiency of survey operations carried on near arterial highways, California roadway engineers have successfully resorted to electrical communication as a means of overcoming the handicap. A "listening aid" of the type commonly used by radio servicemen to detect noises in radio sets has been adapted to the purpose. Suspended near the levelman of a survey crew, it picks up data which he calls off, and transmits them by rubber-covered cable to earphones worn by the recorder. Where bench marks are so widely separated that several stations are needed for vocal communication, the auxiliary system saves much time and insures against errors in the transcription of information. ¶ Mines to which Britons came long years ago for tin to use in commerce with Phoenician traders are active again since Japanese overrunning of the Malay Peninsula. The ancient mines of Cornwall, some of which are more than 2,000 feet in depth, are being worked once more to help in meeting shortages of a metal vital to the war. ¶ Ben Franklin and the speckled ax, as well as various wry adages, are recalled by news that the business of producing sandstone grinding wheels, one of the earliest American industries, is experiencing a revival. Wheels of the natural stone are regarded by many users as particularly desirable for fine grinding, notwithstanding the versatility of the various artificial abrasives. Natural stones are used principally by manufacturers of saws, mill-working equipment, machine knives, and similar products. All cutting tools in an older day were finished on sandstone wheels. Such stones when new were from five to seven feet in diameter, and their peripheral speed was as high as 550 feet a minute. More familiar to the American boy of a generation or two ago, however, was the two-footer which rotated at a rate varying with the nearness of the supper hour, the dullness of the scythe, and the sharpness of the paternal voice. ¶ Bugs and men have various attributes in common, whether admitted or not. Latest to be demonstrated is the instinctive aversion of night insects to a red light. A blue light to them has the go-ahead value of green to the human being. An amber light, it has been found, attracts about 50 per cent fewer insects than does a white lamp of equal candlepower and brightness. ¶ Saving about a ton of metal for each unit constructed, plywood is being used in lifeboats to equip Liberty ships. Contract for a thousand boats was recently awarded to a Portland, Ore., builder, with deliveries beginning last month. Six-ply Douglas fir is used in the new lifeboats, which are 22 feet long and will carry 25 persons. Sails and canvas siding for protection against wind and rain are provided; one out of every four of the lifeboats installed on Liberty ships will be self-propelled. Total cost is about the same as that for metal boats of comparable characteristics. ¶ About a half-billion tablets a year are current production of atabrine, the synthetic substitute for quinine. Territory now held by the Japanese in the Far East was main source of the natural quinine, extracted from cinchona bark, which is the basic medicament for treatment of malaria. Sweeping expansion of facilities for production of the synthetic substitute, which compares well with quinine in mastering the disease, has cut costs so that the atabrine treatment is far less expensive than that with quinine. ¶ If it has not been so annealed as to remove strain or other effects of its earlier treatment, glass at room temperature slowly changes in shape or size even though it appears to be rigid, Nelson W. Taylor of Pennsylvania State College explained to chemists at the American Chemical Society meeting in September. The elastic properties of glass are most conveniently studied in the annealing range of temperatures, below 400 to 600 degrees Centigrade. At room temperatures, much longer time is necessary to permit observation of gradual change; observations taken in the "ice-point" of a thermometer may show continuing changes even after a year. ¶ Glass as a substitute for steel in reinforcing concrete is reported as under investigation in Britain. Architects who have been studying it declare that concrete thus reinforced will carry four times the maximum load specified by government authorities for air-raid shelters. Strips cut from the outer edge of glass sheets as they come from the rolling mill are used. Since these strips are fire-finished, they are regarded as stronger than cut or polished glass, and since outer edges are usually trimmed off and remelted, use of the strips as reinforcements is relatively inexpensive. Difference between the modulus of elasticity of glass and that of steel presents a problem. ¶ In Ecuador, the harvesting and processing of a vegetable sponge are being pushed. The *esponjilla*, with a fruit similar to a cucumber, is a vine that grows wild in tropical America. The outer skin of the ripe fruit is thin and dry, and is readily removed, exposing a spongelike interior structure.

Submarine Warfare

HISTORICAL background and timely analysis of events so recent that newspaper reports of them are still fresh in memory are effectively combined by David O. Woodbury, '21, in *What the Citizen Should Know about Submarine Warfare*.* David Bushnell and his *Turtle*, Fulton and his *Nautilus*, the Bavarian Bauer who built for the Russians the *Diable Marin*, and the Confederate *Davids* are passed in review; the invention of the torpedo is succinctly told. At once thereafter, the reader is taken into swift and solid narrative of German submarine activity in the first World War, with the Allied answer to it. Thus basis is firmly established for understanding of what the submarine has been made to mean in the present struggle, and of how it was made to mean it.

Mr. Woodbury's account of the modern undersea machine is well adapted to lay comprehension, and his description of safety and rescue precautions and of modern methods of training the highly skilled crews essential to submarine warfare is sufficiently thorough. Hence his survey of present operations, circumscribed though it must be by requirements of security, offers good grasp of a mass of otherwise confusing detail.

* New York: W. W. Norton and Company, Inc., 1942. 231 pages. $2.50.

M.I.T. at War

President Compton's Greeting to the Class of 1946 Summarizes the Institute's Varied Wartime Work

TECHNOLOGY'S first formal wartime registration day since 1918 came to an Institute already fully geared to war demands and active to the full extent of its energies on a score of fronts. The 731 freshmen constituting the Class of 1946 matriculated in an environment of quiet and concerted endeavor. Their upper-class colleagues of 1943 had been steadily at work during the summer, under the system which will make possible their graduation on February 1. Professors, instructors, assistants had been consistently occupied on research and development projects concerned with the war effort. Many members of Faculty and administration had been busied in Washington or elsewhere, contributing their special skills to the wartime needs of the nation. Thousands of Alumni enrolled in the uniformed services and thousands more engaged in vital posts in war industries were continuing the tradition of Technology service in crisis. More than double the usual number of teaching and research staff were operating in classrooms and laboratories.

Total enrollment of students during the year past had increased some 50 per cent above the ordinary figure as more and more young men came to Technology for special war-training courses. The uniforms of many of these vividly symbolized the main preoccupation of the school in a time of stress. The physical environment to which the new-coming students were welcomed bore a good many other specific evidences of unusual activities. But there were fixed points through it all, and sure warranties that the steady course of education, become more important now than ever before, would be pursued still with direct and firm intent.

Recently returned from his services with the committee named by President Roosevelt to report action to meet the perplexing rubber situation, President Compton greeted the men of 1946 informally at a brief convocation in the Great Court of the Institute on the afternoon of September 26.

That evening, speaking before the all-Technology smoker in Walker Memorial, where a record attendance was gathered, he welcomed them officially, describing for them the larger aspects of the Institute's manifold activities and counseling them on the conduct of student life in troublous times. In its friendly and purposeful tone, Dr. Compton's address well embodied the mood of the evening.

"Not only is your Class unusual in being the first to enter the Institute during this war," he said, "but, because of the war, it is also somewhat different in composition. You were selected from well over 2,000 applicants for admission, the largest number of bona fide applications for admission ever received in the history of this institution. You are the largest Class which has been admitted since the size of the freshman class was limited to about 600. Our present estimates are that your Class will number about 730 by the time registrations are complete.

"These increased numbers are due to the added emphasis placed on scientific and engineering education by the exigencies of the war, for both the fighting forces and the national economy have to be geared to the use and the production of highly technical equipment. Many students who might normally have attended a liberal arts college — some of whom might subsequently have undertaken scientific or engineering postgraduate studies — are now added to the group of about 600 who would have entered the Institute at this time under normal conditions. We believe that you have made no mistake in coming here, for not only is the type of education provided at this institution of unusual importance in time of war but it will also be of great value in the period of economic readjustment and reconstruction which will inevitably follow the war.

"You come to an institution whose activities have been profoundly modified by the war. For example, while our normal teaching and research staff number about

George H. Davis

President Compton speaks to the Class of 1946 at informal convocation shortly before registration day for the first class to enter M.I.T. during the second World War.

550, there are at the present time about 900 scientists and engineers on our campus working full time on various war projects, and more than 200 members of our normal staff have either joined the armed forces or are otherwise engaged in direct war activities. Our movements are limited by guards and passes, and portions of our educational plant and recreational facilities have been taken over by the military authorities. In this setting we enter upon our educational program for the coming year. Despite the readjustments required by these conditions, however, I can assure you that the educational program can, with your co-operation, be fully up to the high standards of Technology.

"Actually the basic setting for the work of the coming year can be stated very simply: You are here to secure the most thorough type of education and training. We are here to help you get it. If we all keep this basic fact in mind and do not let side issues becloud the main one, the outlook is straightforward and our program will be successful.

"The spirit in which we pursue our educational program must be adjusted to the necessities of wartime. Our nation requires a tremendous uplift of morale if it is to come successfully through the present crisis. We have serious spiritual handicaps to overcome as a nation.

"Many people take as for granted that the United States cannot be defeated. But thus far the facts of the situation do not justify any such optimism. We are in a fight to the finish against two principal enemies who have spent years of preparation for the struggle. While they have been sacrificing personal comforts and working with almost fanatical zeal to build up efficient military machines, our country entered the war period with the general attitude of 'business as usual,' with war preparation being relegated as a side issue. Our national policy is still torn by economic and political groups striving for advantage. The democratic principles which we firmly believe are best suited to the long-time development of a free and happy people permit individuals and groups to hamper very seriously our effort in this period of crisis.

"Several million young men and women are now enrolled in the armed forces and are giving everything they have to the defense of the principles which we hold dear. Many millions of others, young and old alike, are also making great personal sacrifices to the same end. Until and unless our entire nation can be united in the same spirit of sacrifice, realizing that the time has come when we do not deserve our liberties unless we make supreme sacrifices to retain them, we will continue to fight a losing battle.

"This is the serious side of the setting into which our educational program in its spirit and its content must fit. To do so, it must be operated very efficiently. Our staff have added responsibilities and are carrying abnormal burdens. They have not, and should not take, the time to worry over thoughtless student escapades or struggle to drive students who do not supply their own motive power. Thus the general policies of this institution can be expected to be more than usually 'hard boiled,' the staff being helpful where help is deserved but not wasting time on situations which are not constructive. We ask your co-operation in this matter, for it is one of the war necessities and it is all to your advantage.

"Furthermore, our program must be continually adjusted to such rules as are laid down by the Federal authorities. These rules principally concern the conditions under which students may continue in college. The basic principle underlying the rules is that in this emergency no student has an inherent right to go through college. On the contrary he, like everyone else, has a duty to perform to his country; his opportunity for continuing a college career is primarily dependent upon evidence that by so doing, the effectiveness of his service to the country will be increased.

"With so many members of our staff intimately connected with the technical aspects of war activities, both in the uniformed services and in industrial production, we have an unusually strong reason for our belief in the importance of providing technological training to young men and women who have shown capacity to take advantage of this training and who show promise of using it effectively. In so far as we and similar technological institutions have influence in the matter, we may be counted on to make every effort to see that the opportunities for this training are continued in order to meet the extremely critical need for more and ever more technically trained personnel. Thus far we have found the army and navy authorities and the draft boards on the whole to be very understanding and cooperative in view of the difficult requirements which are placed upon them. As the war continues, we may expect some change in the regulations under which we have to operate, but I believe that the technological needs of the country are sufficiently well understood by those in authority to insure wise and competent handling of these questions, even though some false starts and some minor mistakes may be made.

"In conclusion, let me say a very few words about you and your personal problems.

"Youth has always been the period of great idealism. A reserve of power to meet crises is possessed in greater proportion during youth than during any other period of life. In normal and more easygoing times, the incentive and the challenge which cause people to rise to high peaks of performance are frequently lacking, but the incentive and the challenge now confront all of us. I have full confidence that you of the entering Class of 1946 will rise in outstanding fashion to meet the situation which faces you. We realize the serious problems which confront you personally. Some young people are inclined to worry unduly about the future. Others are perhaps inclined to shut their eyes to the seriousness of the situation and irresponsibly go in for a good time while they can. A proper balance between these extremes is what we should strive for at this time. If we can be serious and purposeful without worrying, if we can have a proper amount of recreation without wasting time, if we can do the job before us to the best of our abilities, we shall have performed our duty in the coming year and shall find confidence and satisfaction.

"In this spirit and with this faith we welcome you to the Massachusetts Institute of Technology."

The Center of the Problem

Cultural Relations, As They Establish Understanding and Unity of Purpose among Nations, Are Vital to Victory

By Robert G. Caldwell

WHEN William Wheelwright left Newburyport, Mass., in 1823 to build railroads in South America, he traveled more than a year and met with numerous adventures before he reached Valparaiso. Once, in 1829, he made what he called "a hurried trip" back to his old home town in New England to marry the girl who was still waiting for him. After that, echoes of New England reached him only dimly and occasionally. Now, he could be married and get back almost within the same week. In terms of effective distance the steamship, the submarine cable, the Panama Canal, the radio, and the airplane have occasioned not one revolution but a whole series within three generations.

One of my predecessors as minister to Bolivia in the Eighties lived in a pleasant valley of the Andes, eight days' journey from the somewhat bleak mountain capital to which he was accredited. He got away with it until the very close of a four-year term, when, by what was at the time almost a miracle of hard luck, the empty legation of the United States was visited by a Senator from Delaware, who was shocked to find no visible representative. In those days not even the State Department, certainly no one else, cared what might go on in a country that might well lie in the moon. Today Bolivia, the only remaining United Nations' source for tin and tungsten, is our good neighbor. No day passes without some direct message from Washington, and the embassy of the United States in La Paz is the meeting place for hundreds of busy visitors.

Unfortunately, contact is a very different thing from understanding. Cultures which spring from different sources remain diverse, and when they meet they are as likely to create conflict as understanding. For we live in two dimensions: One is of miles and space, which may be easily spanned. But the other — of years and time — must also be bridged, and this result can be achieved, if at all, only by conscious effort. Just as 6,000 miles separate Boston from Valparaiso — miles which have shrunk to inches — so perhaps 100 years separate them as well — years which do not so readily change to minutes.

Indeed, we may well wonder whether a modern war is not in itself a by-product of a smaller world composed of men who remain diverse and spiritually distant. Events in far places are now brought directly to our attention within an hour by radio, press, and cable. Soon after, we see them depicted, with all their emotional implications, in the cinema and the modern pictorial magazine. Thus we are daily brought face to face with cold and brutal facts which we once ignored and which we are not yet trained to interpret or to understand. Certainly our grandfathers, in Wheelwright's time, would have known little and cared less for the wrongs inflicted on Czechoslovakia or China. And the control of 90 per cent of the world's rubber and 70 per cent of all the tin by the Empire of the Rising Sun would not then have seemed a danger or a threat. Today, for better or for worse, we are seeking consciously to bridge the years, which, even more than the miles, lead to conflicting interests, to differences of manners and of speech, and so to misunderstanding.

Increasing cultural contacts with Latin America certainly have gone far to create a popular demand for collaboration in a time of danger and a genuine movement for hemispheric solidarity from which even the most distant countries — Chile and the Argentine — have found it none too easy to remain aloof. The Rio Conference of 1942 was a great diplomatic triumph, for

The Door of Honor of the Government House in Lima, erected by Francisco Pizarro, who founded the city in 1535

which the way had been paved by numerous less spectacular measures. Delegates of many countries received telegrams and letters which soon showed that the steps they were there taking had an unexpected mandate the roots of which went back to a thousand distant hamlets. The contrast between the present active collaboration and the critical attitude of such countries as Mexico, Colombia, and Venezuela 25 years ago did not come by any accidents of passing of time alone.

Now we are at war, and that very fact raises a question: Can we afford to devote time and energy to remote ends? The methods which were used in Latin America, for example, are granted to be fruitful, but to some they seem slow, better suited for the establishment of sound relations after the war than for the winning of victory tomorrow.

A program in time of peace, at least for the Western Hemisphere, might reasonably include the following divisions: (*a*) political measures; (*b*) economic relations with regard to commodities, shipping, loans, and new industries; (*c*) social welfare, including mutual assistance in such matters as nutrition, public health, child welfare; and (*d*) cultural relations based on a sincere effort to appreciate and understand the way of life of other people, to answer questions like these: Where do you live? Who are you? How do you make a living? What do you think?

Before the war, for certain nations of Europe, for China, above all for Latin America, a beginning had been made to envisage our relations in such broad human terms. Now, however, some would say we can't afford the time, the energy, perhaps the money. Let us shorten the program, narrow the objectives. Contacts between artists, scholars, and musicians cannot possibly win the war, which win we shall and must.

Martin Rosse, '40

Indians from the state of Oaxaca at one of the colorful fairs in the city of Oaxaca, Mexico.* Indianismo *is a factor in the international equation of the present.

The new program, then, would read: (*a*) exertion of direct political pressure to keep governments on our side; (*b*) provision of such economic assistance as may be required to secure the raw materials necessary for war effort: tungsten, copper, tin, rubber; and (*c*) inauguration of a so-called psychological program to present our war purposes to other nations. In short, we would make use of direct and immediate methods varying from political promises to the supposed — and, as I believe, wholly overestimated — advantages of direct war propaganda. At a time when revolutionary changes demand new concepts, we are asked in the name of realism to return to what are after all only the time-worn methods of the past.

THREE aspects of the life of our time which seem to me essential factors of this problem are the spread of industry, the rising demand of submerged groups to share a higher standard of living, and the transfer of the world's cultural center to the Western Hemisphere.

Since the last War, the old division between industrial nations and producers of raw materials has become, to a large degree, unreal. Factories producing consumers' goods are now found in the most unlikely places — witness the industrial revolution which is taking place in South America under our very eyes. Even heavy industries, once the monopoly of England, later of Germany, France, and the United States, are rising in new countries. It has been estimated that in 20 years enough industries have been started in nonindustrial countries such as China, Brazil, Portugal, and many others to equal in the aggregate the industrial capacity of a major power. Clearly the end is not yet. The new industrial revolution is the industrialization of the world. That is the first great fact of our times.

This tendency has been greatly accelerated by the war, with permanent consequences which no man can measure. In Argentina the promotion of new stock companies in 1941 broke all previous records. Consumers' goods ranging from canned foods to clothing, shoes, and textiles are rapidly replacing previous imports. In Brazil the new cotton and rayon mills supply an actual export surplus. The rise of heavy industries in these countries is equally surprising. Argentina is already an important producer of dyestuffs, refrigerators, electric motors, porcelain, and special glass. The new steel mill in Brazil, financed by the Export-Import Bank of Washington, is expected to bring the country's capacity to more than 1,000,000 tons. New products, such as cafelite, are planned on an export basis. The great Itabira iron deposits have been acquired from British interests by the government of President Vargas and are now in process of rapid development.

Trade within Latin America has already gone a long way to take up the slack left by the blockade of Europe. The dollar value of the trade of Argentina, Brazil, and Chile, negligible before 1914, reached $270,000,000 in 1941, compared with $170,000,000 in 1938. Last November, Brazil and Argentina entered into a trade agreement providing for free entry of goods produced

Copacabana beach at Rio de Janeiro, Brazil, where metropolis meets ocean

by any new industries in either country. Similar arrangements elsewhere below the equator seem to forecast what has been called "a progressive customs union" based on the production of noncompeting goods.

Then, too, we have that ominous stirring of the depths, which Ortega y Gasset called "the revolt of the masses." Only a few years ago, for example, *Indianismo* did not exist as a practical reality on the west coast of South America; the indigena was a mere source of unsatisfactory labor; the negro race of Brazil and the Cauca Valley was illiterate and unregarded; the Malayan coolie was merely a tiller of the soil. Today the demands of such submerged groups can no longer be disregarded. Consider likewise the nationalism of India and of China: No matter who holds Hong Kong, Calcutta, and Shanghai, it is a very blind man who does not see that the old-fashioned cultural and economic imperialism of the Nineteenth Century is gone forever.

Take Latin America. Even several years ago, if a person gained the ear of a few leaders in less than two score cities, he might say he had opinion on his side. Now the conscious group is made up of thousands, tomorrow of tens of millions, whose power for good or ill is almost incalculable.

When, at the close of the last War, the center of economic and financial gravity passed from London and Paris to New York, political responsibilities and economic duties arose which my generation recognized only in part. Today, it seems to me, the revolutionary changes are even deeper and more permanent. Overnight, America has become the custodian of exiled cultures — one of the few countries where scholarship, literary and artistic pursuits, scientific research, are readily possible. As surely as the banking capital came to us 20 years ago, today the Western Hemisphere has become the cultural center of the world. The change may be merely temporary; but whether short or long, it is a third great fact of our time. On this side, too, we have an appointment with destiny. Peace, yes; but for America, new tasks and new opportunities which should make the next period in our history rich and full for the generation to which we belong.

Not so many years ago we deliberately opened up Japan willy-nilly. We taught the Japanese the techniques of mass production of things. We taught them also how to become possessed by the urge to have things and how to inculcate among the millions of their people that sort of mass demand for the products of the factory. It appears now that we must have done only a partial job of instruction, that we must have failed to teach them the necessary further lesson of how to govern both those things and that urge to have things. We may then by some be rated as now consequently reaping the whirlwind. Shall we, as we watch the production line, 1942 American model, being set up in Cambodia or in Patagonia, be content with merely passing on technical adroitness and commercial acumen and thus sow another wind whence our grandchildren will reap another bitter harvest? It seems to me that one of the most important international responsibilities rests upon us all to try to comprehend the spirit and the philosophy of pastoral and agrarian peoples whose lives are bound to suffer extremes of dislocation as a result of their adoption of our mechanical and industrial wizardry. At the same time we must make the most sincere and earnest effort to render comprehensible to them those elements in our own nature and temperament which have permitted us to industrialize to so good a degree and to survive that industrialization with no greater grief than we have suffered.

PUT the matter another way. Caught by cataclysmic forces which none of us measured, we find ourselves in the midst of war, a war which we can lose — let us make no mistake about it — but which we are highly resolved to win. On what do we count for victory? We might perhaps enumerate the elements of victory as follows: the justice of our cause, (*Continued on page 36*)

Toward a Modern Aesthetic

The Possibility of Error in Art Provides Basis for a Theory of Why Some Forms Satisfy and Others Do Not

By Amédée Ozenfant

YES, art changes from century to century, or from one decade to another, and from artist to artist. Works vastly appreciated at one time have perished. Others, admired today, will perish. Others, forgotten for a moment, recover their vogue, their utility. I do not deny these facts. And certainly it is interesting to study the variations of public taste through the ages. A great many writers have done it very well.

But what is this vaunted public taste really worth? It is regarded as Truth in its own time. Occasionally, as in the great Egyptian, Greek, Chinese, Romanesque, or Gothic epochs, it *was* Truth. Let us look not at the aristocratic works of great artists, predestined beings, rare and exceptional, but only at the humble domestic things of the little people of these great ages: the "tools" of life created and utilized by these little people for their own purposes. We are struck with admiration for their extraordinary artistic sense. Their least "five-cent" earthenware vase honors our art museums and puts to shame the great majority of our so-called art vases. In those distant times the reaction to forms was *normal;* today it is very often corrupted. Ask the generality of Americans or Europeans of our day to choose between an Egyptian, Chinese, Greek, or even Pueblo earthenware vase, humble but of the most superbly pure form, and one of those ridiculous, costly, ornamental vases which nowadays are stacked in the shops throughout the world. Perhaps 95 per cent of the people everywhere in the world would choose the stupid vase. Am I an optimist? I am afraid so. To the contrary of what is said, an enormous quantity of art is bought all over the world. But 95 per cent of it more bad than good. I submit: There are epochs when the taste of the public is generally true; at other times, like ours, it is often false. False because people are "deformed," perverted, at least in art.

I lack the space to analyze all the causes of this sad fact. Let me give a single example: I met a lady who had in her home a collection of beautiful things consisting of pebbles, plants, sea shells, dresses, furniture. But on the walls such stupid pictures. "How is it," I asked of her, "that you could choose the most beautiful from the millions of forms on the beach, in the forest, in the shops, and yet could buy those idiotic pictures?"

"Ah," she replied, "that is not the same thing; that is art."

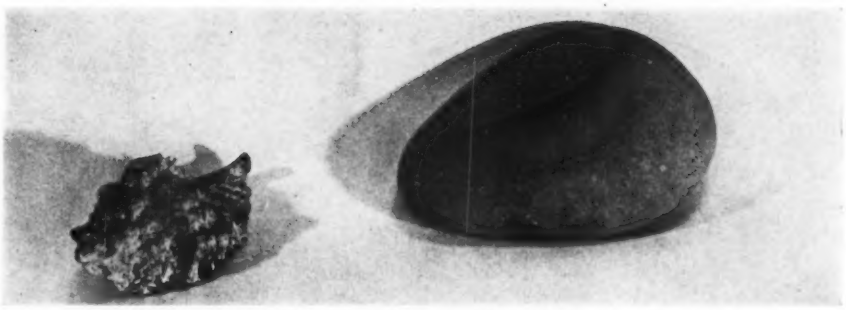
This little story suggests several actualities from which I shall point out only this: The majority of people are capable of reacting normally to forms in nature, outside of art, but not in art. My adventure also shows that a bad work of art can produce strong emotions. A great shame, but so it is. A miserable picture (Fig. 1), representing Othello recounting his battles, generally impresses the majority, who remain perfectly insensible to the harmonious parabola of a vase worthy of a J. S. Bach. As long as one approaches art with the conviction that in our day the majority, because they are the majority, necessarily have true judgment, one will understand very little. One could seek by means of the most thorough and difficult statistics, and one would find in this age only the norms of poor taste and not the norms of the best. The latter

Fig. 1. Scene after a Cabanel "tableau"

Metropolitan Museum

Fig. 2A

exists, but it is rare, exceptional. The normal approach to art is exceptional. *The normal, in this age, is the exceptional.*



A *Fig. 3* *B*

FOR 20 years I have tried to approach the problem of art from an angle quite other than that of the taste of the majority or the "sophisticated" tastes of certain sophisticated specialists. The essay has led me, in passing, to certain ideas much opposed to current opinion. Especially has a conception of form, which I shall now sketch, imposed itself upon me.

This theory is based on the possibility of *error* in art. Here is a Form (Fig. 2*A*). I have purposely chosen an object of the humblest sort — an Egyptian makeup palette. It is a very simple Form, pure enough. It might be still purer. But at all events anyone, unless blinded by false ideas and artistic toxins, will feel that it is a reasonably good Form. Modify it slightly (Fig. 2*B*). Now this Form is less "good" than at first. Note that I could no doubt better the original Form — for example, on the side of the fish's tail. My modification in itself, however, spoils the Form. It is an error. An error against what? I say, against a *need*.

More precisely: Form 2*A* *satisfies* us more than does Form 2*B*. Hence:

(1) If a Form satisfies us, that fact proves that something in us *desires* it, *needs* it, just as it is. But can you imagine a satisfaction which would not have been preceded by a need? The "Form" of the need, then, was necessarily and veritably something very near to that Form which was discovered and materialized by the Egyptian artisan.

Despite a horror of neologisms, I have nevertheless permitted myself to call the Form required by the need the "Preform." A satisfying Form is one that satisfies a Preform. A Preform can be very simple, or it can be as extraordinarily complex as a work of high art.

Fig. 2B

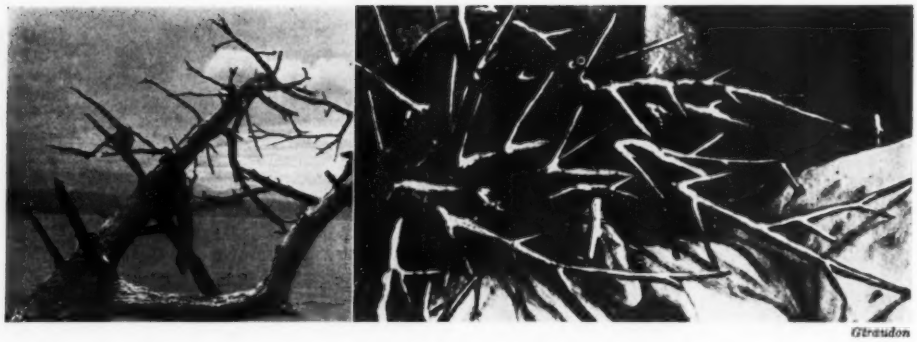
(2) A healthy sensibility "looking" at Form 2*A* without prejudice receives satisfaction from it — a fact which tends to prove that the Preform of this Form, created more than 40 centuries ago, existed among the old Egyptians, and, since the Form still satisfies us, that the Preform still exists. (Thus one is allowed to hope that the quest for constants in artistic psychology, at least, is not so vain as is often said.)

It seems to me, then, that henceforth one may grant that the architects of the Pyramids and the Parthenon necessarily had within themselves the *total* Preforms of the Pyramids and the Parthenon, and that all those who have admired these edifices have necessarily had within themselves the complete Preforms. Necessarily, we still have them within ourselves, since these masterpieces continue to satisfy us.

Abstractly summarized, *a Preform is the Form of a need*, an energizing or potential psychologic Form awaiting its objective projection. The Preforms are the constants. They are the known or latent basic needs of humanity, some already known and satisfied, others awaiting the discoverer who will create the work capable of satisfying them. A masterpiece may be conceived as the perfect materialization of a Preform.

To be precise: When, at any time during the centuries, an artist or a group of artists have created a masterpiece, they have discovered the means of satisfying a potential social need. That Preform pre-existed in all techniques, in all disciplines. To discover a need and the exact Form of that need is, in some sort, to conceive the masterpiece itself. We know of entire series of primitive Parthenons in numerous countries, stretching back to the most remote times of antiquity — attempts to satisfy the latent need for the Parthenon. But the exact Form of the Preform, the Form of the social need, was clearly and completely discovered by Ictinus and Phidias in the Greece of the Fifth Century B.C., only after centuries of attempts, more or less successful.

Every future masterpiece pre-exists potentially as an



Left, Fig. 4: Dead tree, Seattle. Right, Fig. 5: Detail from the retable at Isenheim, by Matthias Grünewald.

Giraudon

unknown need in the heart of humanity. According to this conception, the true artist is not a sort of monster, even though he is an exception; he is the most normal of men. He is the diviner of human needs of which humanity often is ignorant. And because he is capable of reaching the Preform, the great artist is capable, by the power of his creation, of satisfying humanity. Thus he is among the most useful of men. The great artist, the great scholar, the great philosopher belong in the same class of human value, the highest.

This conception of the Preform contains, I believe, some interesting philosophic implications. Aesthetics has generally been approached from the point of view of psychology; it would be possible to begin with aesthetics and to extend the idea of Preform to psychology, to philosophy, to the philosophy of science, and so on.

In either individual or social psychology, for example, the need of liberty is a Preform. Or, more exactly, liberty is a class of Forms. Each Form of liberty is a Preform.

Take mathematics: 2+2=3,754. . . . What a crime! We suffer; a Preform is shocked. 2+2=4. . . . Peace, a Preform of the equality class is satisfied. 2+2=5. . . . The error is less serious; we suffer, but less.

We can now try to define the word "quality": The degree of adaptation of the Form to the Preform is the measure of the quality of the Form. The definition can be extended to other categories of human activity.

All possible *progress* is contained in the stock of undivined Preforms. Possible progress resides also in the margin of imperfect adaptation of Forms to Preforms — aesthetic, philosophic, scientific, social, mechanical, and so on. For example, if man had no Preforms, speculative mathematics would be only empty formalism. It would be inconsequential, a conventional game. But for the moment I am confining myself to a few ideas, the first steps toward a normative aesthetic.

To cut short certain criticisms, I insist that this aesthetic, despite its "mystic" implications, is realism and not idealism, the axis of reference being to real man.

The Preforms are of a hedonist nature. Satisfying them gives pleasure. A pleasure can be mediocre (Petty girls) or elevated or even sublime. Every satisfaction produces the opposite of a discomfort. Normally man prefers to be caressed rather than beaten, but the pleasure is only the accompaniment of the aesthetic satisfaction, an epiphenomenon.

Yet important works of visual or auditory art — or, perhaps, parts of these works — give no pleasure and sometimes even cause more or less pain. One may counter this implicit criticism by the fact that even though man prefers to be caressed rather than beaten, too many caresses or too much facility therein soon bores him. (The curve of pleasure-fatigue corresponds to that of all excitation.) The Forms that will satisfy the Preforms fully may require some contradiction: antagonistic forms, colors, textures, and so on. . . . A certain "play" between Preform and Form is often useful. In fact, "play" exists more or less in everything, perfection not being of this world. This, for the rest, leaves the road to progress open. . . .

We can now divide the keyboard of all possible Forms into two opposing categories: one, comprising the Forms of Preforms, which we shall call sympathetic (Figs. 2*A*, 3*B*, 6*A*); the other, the antagonistic Forms (Figs. 3*A*, 4, 5, 6*B*). (*Concluded on page 36*)

Fig. 6. Face constitutes section A; background to right and left, section B.

Louvre

Steamboat Round the Bend

American As Corn Whisky Were the Vessels That Plied Eastern Rivers and Sounds As the United States Grew Up

By W. Mack Angas

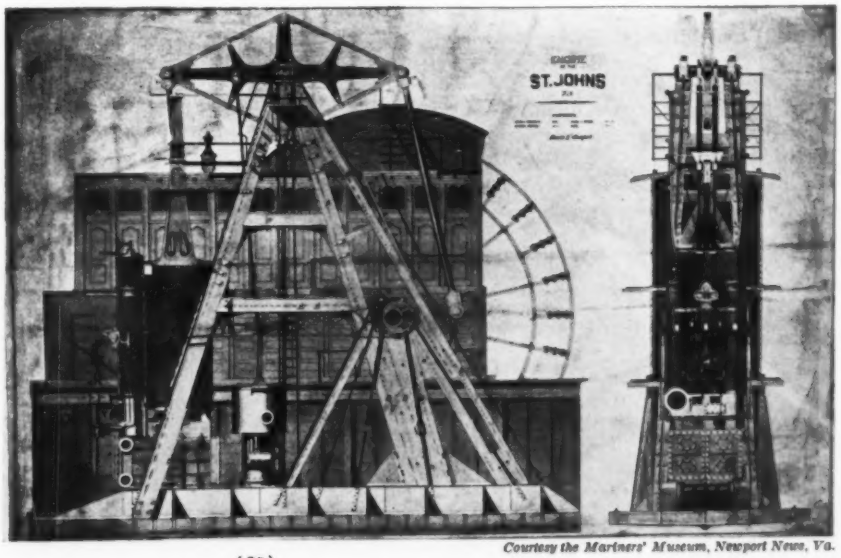
THE story of American river and sound steamboats, particularly the vessels built in the first half of the Nineteenth Century, forms a chapter in the history of transportation and marine engineering of which we may be justly proud. River steamers have been built and operated in many parts of the world, but those which played such an important role in the development of the United States were peculiar to this country. Admired for their speed, condemned because of their propensity for blowing up, criticized by foreign engineers as the crude product of a frontier people, they were in fact often driven by machinery years ahead of that used in contemporary European vessels. The steamboat was as American as corn whisky.

Fulton's *Clermont*, which started its epoch-making voyage from New York to Albany on August 17, 1807, was the world's first commercially successful steamboat. Its flat-bottomed wood hull was built in New York by Charles Brownne and, as originally constructed, was 133 feet long with a beam of 18 feet. The cylinder and many essential parts of the somewhat peculiar condensing engine* which drove the *Clermont* were built in England by the firm of Boulton and Watt. Propulsion was by uncovered and unprotected side wheels, which jealous bargemen soon found to be extremely vulnerable to damage in minor collisions. Because the boat could average about five miles an hour from New York to Albany, it clinched for Fulton and his partner, Robert R. Livingston, the exclusive right and privilege to operate steam vessels on the waters of New York State. (The state legislature had granted them this monopoly for a period of 20 years provided they would produce a boat of not less than 20 tons' burden which would move with or against the current of the Hudson River at the rate of four miles an hour.)

The monopoly thus granted to Fulton and Livingston had a far-reaching effect on the early development of the steamboat. At first it was no doubt beneficent, as it encouraged the investment of capital and expedited Fulton's personal contributions to the development of the steamboat and steam navigation — contributions which by no means ceased with the demonstration by the *Clermont* of the practicability of a new method of transportation. Later the Fulton monopoly, which outlived the inventor by nine years, did much to hamper the development of the steamboat and throttle the enterprise of engineers and inventors eager to make worthwhile contributions to the infant science of marine engineering.

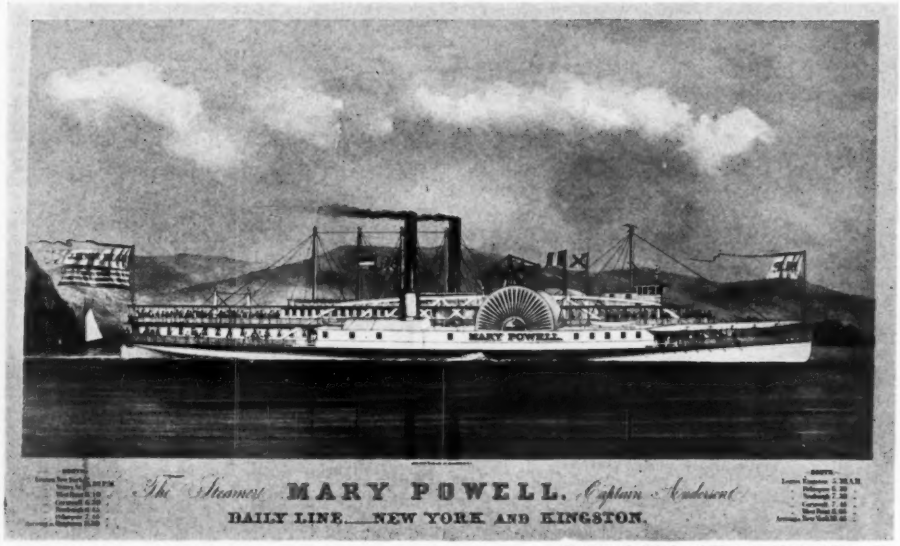
Though the *Clermont* of 1807 was a success, Fulton nevertheless immediately set about improving her. After her first season she was virtually rebuilt, her length being increased to 150 feet and her machinery considerably improved. The alterations included the replacement of the outboard flywheels with a single inboard wheel, the provision of paddle boxes over the side wheels, and the installation of heavy guard timbers

* For a description of the machinery of the *Clermont* and a reproduction of one of Fulton's drawings of the engine, see The Review for March, 1940, page 192.



A typical beam engine was that of the steamer St. Johns, *built by Harlan and Hollingsworth. The bore of the cylinder was 66 inches, and the stroke was 12 feet.*

Courtesy the Mariners' Museum, Newport News, Va.



Courtesy the Mariners' Museum, Newport News, Va.

Mary Powell, *one of the fastest and easily the best-known of all Hudson River steamers. As originally built by Michael S. Allison in 1861, she was 260 feet long and 34 feet 6 inches beam. She was then driven by a beam engine manufactured by Fletcher Harrison and Company and having 62-inch bore and 12-foot stroke. In 1874, she was lengthened to 300 feet over all and fitted with a beam engine of 72-inch bore and 12-foot stroke. The Herreshoff steam yacht* Stiletto *won great publicity in 1885 by beating the* Mary Powell *from New York City to Tarrytown.*

outboard of the wheels to protect them in case of collision and to support outboard shaft bearings, the necessity for which had been demonstrated early in the career of the boat. The vessel as thus reconstructed went into service in 1808 under the name *North River.*

The conversion of the more or less experimental *Clermont* into the passenger steamboat *North River* did not absorb all Fulton's energy, for at the same time he designed the *Raritan* for service between New York and New Brunswick and the *Car of Neptune* for his own Hudson River line. These boats were followed by *Paragon* in 1811, *Fire Fly* the following year, and *Richmond* about a year later. During the same period, Fulton designed and built several ferries for service between New York and Jersey City and between New York and Brooklyn. The first of these steam ferryboats, which were catamarans, had hulls 80 feet long and 10 feet wide with a space 10 feet wide between the hulls; the over-all beam of the vessel was therefore 30 feet. The boats were double-enders, running in either direction with equal facility; wagons were driven onto the ferry at one end and off at the other, as with the present-day conventional ferryboat. A single paddle wheel between the hulls drove the Fulton ferries, an arrangement that still persists in many of the ferries which operate today on the lower Mississippi.

Fulton apparently did not find it necessary to import machinery for any of the steamboats he designed and built after the *Clermont,* the engines of his later vessels being constructed in a machine shop he erected for the purpose. Castings were purchased from Robert McQueen and John Youle, both of whom operated iron foundries in New York, and brasswork came from the New York plant of James P. Allaire, who at a later date took over Fulton's shop and became one of America's most successful and prominent marine-engine builders. Fulton's machine shop was first located in Jersey City and was later moved to New York. Its equipment included a boring mill capable of machining the relatively large cylinders of his low-pressure engines.

The engines devised by Fulton for his later boats were low-pressure, condensing, double-acting, single-cylinder machines fitted with poppet valves actuated by a plug tree. Thus they were fundamentally of the same type as the Watt engine of the *Clermont,* though their arrangement was simpler and more compact. The newer engines retained the vertical cylinder and wide crosshead running in guides supported on a gallows frame which had proved successful on the pioneer boat, but the cylinder stood directly between a pair of gear wheels secured to the inboard ends of the port and starboard paddle shafts. These gear wheels, being fitted with crankpins, were also disk cranks. The lower ends of the connecting rods engaged the pins of the disk cranks, and the upper ends were carried and actuated by gudgeons attached to the crosshead. As in the *Clermont,* the two paddle shafts were connected by gears which were mounted on the flywheel shaft and which meshed with those on the paddle shafts. The arrangement closely approximated that of the crosshead, or steeple, engines which later attained wide popularity on eastern steamboats. It does not appear that an effective attempt was made to use steam expansively in any of Fulton's engines. The boilers on all his boats were much like that on the *Clermont.* Made of copper, they were elliptical or cylindrical in shape, and their single return flue terminated in a smokebox and stack which were located over the furnace doors and were mounted on a brick setting that contained the furnace and ashpit.

During the life of Fulton's monopoly, the ideas developed by American inventive ingenuity were not given an opportunity to be tried on the highly profitable routes afforded by the Hudson and other inland waters of New York State, but elsewhere engineers were making experiments and progress. Chief among American inventors giving time and effort to the development of the steamboat at this time was John Stevens of Hoboken, who was ably assisted by his son Robert. Having been associated with Fulton's partner, Chancellor Livingston, and with Nicholas Roosevelt in the construction of

experimental steamboats before the *Clermont* was built, Colonel Stevens had a long-standing interest in steam navigation. After the termination of his association with Livingston, Stevens and his son in 1804 built and operated in New York Harbor an experimental twin-screw steam launch, the *Little Juliana*, and they were only a short time behind Fulton in producing a commercially successful steamboat. This vessel, the *Phoenix*, was propelled by side-wheels.

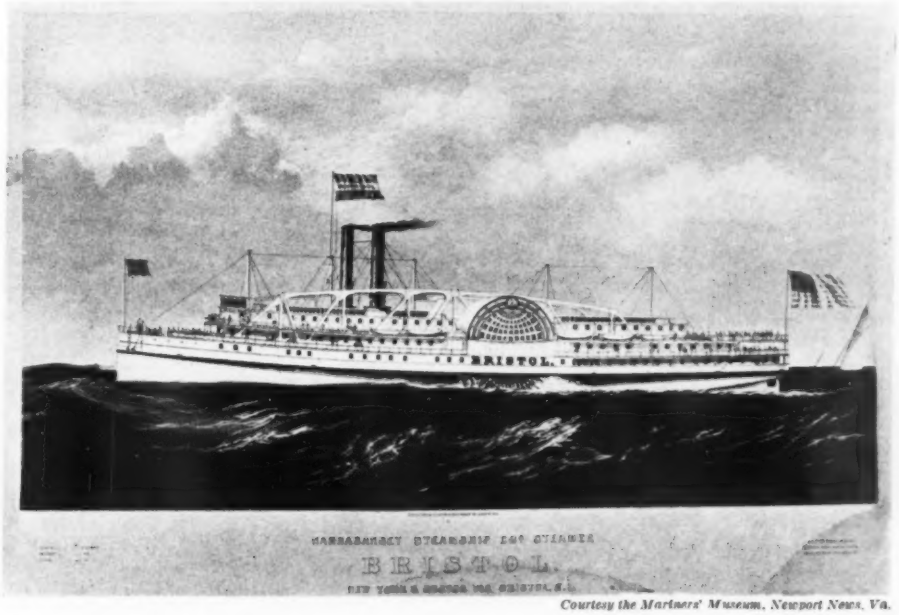
In discussing the adoption of side-wheels for this vessel before a meeting of the Society of Naval Architects and Marine Engineers in 1909, Edwin A. Stevens said: "Col. John Stevens abandoned the use of the propeller after his experiments of 1804 and 1805, for the reason that he was led by these experiments, on a small launch twenty feet long, to conclude that the diameter of the propeller necessary for the commercial navigation of the Hudson River would be so great as to prevent the boat from passing over the Overslaugh shoal, and thereby bar the vessel from access to Albany. The statement that he was influenced in passing from the use of the screw-propeller to the side-wheel by his son Robert L. Stevens is perfectly correct and accurate. That I believe to be the fact, but Col. John Stevens, to the end of his days in the late thirties, was always a constant advocate of screw propulsion. He always claimed that screw propulsion would eventually supersede propulsion by side-wheels, and merely waited for the perfection of the steam engine to allow the use of propellers of small enough diameter to become practicable."

Very probably the second reason given above was Stevens' primary one for adopting side-wheel rather than screw propulsion for the *Phoenix*. He unquestionably believed in the screw but doubted the ability of engine builders of his day to construct machinery capable of sustained operation at the speed necessary for driving a propeller. The side-wheel machinery which the Stevens', father and son, built for the boat proved reasonably satisfactory, but the terms of the Fulton monopoly prevented use of the *Phoenix* in New York waters. In 1809 the Stevens' had her taken to the Delaware River, and she ran between Philadelphia and near-by towns for several years. The *Phoenix* made the trip from New York Harbor to the mouth of the Delaware under her own power, with Robert Stevens in charge of the machinery and Moses Rogers in command. Ten years later, Captain Rogers commanded the *Savannah* on her famous voyage to Europe and thus became not only the first man to command a steam-driven vessel on a voyage in the open sea but the first to command a steam vessel on a transatlantic voyage.

On the Delaware, the *Phoenix* was soon joined by steamboats constructed by the Stevens' and others. Among these the *Philadelphia*, built by the Stevens' at Hoboken in 1813, is of considerable importance because her machinery was altered in 1815 to make effective use of the expansive power of steam.

The most accurate and reliable source of information on these very early American steamboats is, oddly enough, a French publication. In 1819–1820 a French naval engineer, Jean-Baptiste Marestier, visited the eastern states to examine and study the steamboats running on our rivers and sounds. Fortunately a few of our libraries have copies of his beautifully illustrated *Mémoire sur les bateaux à vapeur des Etats-Unis d'Amérique*," published at Paris in 1824.

When Marestier visited this country, the practical steamboat was not quite "in its teens"; yet about 40 steam vessels were running on the Hudson, on Long Island Sound, and on adjacent waters. The North River Company, founded by Fulton and Livingston, was still enjoying the advantages of its monopoly, and Marestier devoted a considerable part of his *Mémoire* to its vessels. He went to both Philadelphia and Baltimore, however, to see the steamboats of the (*Continued on page 40*)



Courtesy the Mariners' Museum, Newport News, Va.

Bristol, ***built with her sister ship*** **Providence** ***in 1866–1867. When they went into service, they were the largest steamboats on Long Island Sound. They ran from New York to Bristol, R. I., connecting there with trains to Boston. Their huge beam engines, 110-inch bore with a stroke of 12 feet, could drive them at 19 statute miles an hour.***

Transmitting, Bending

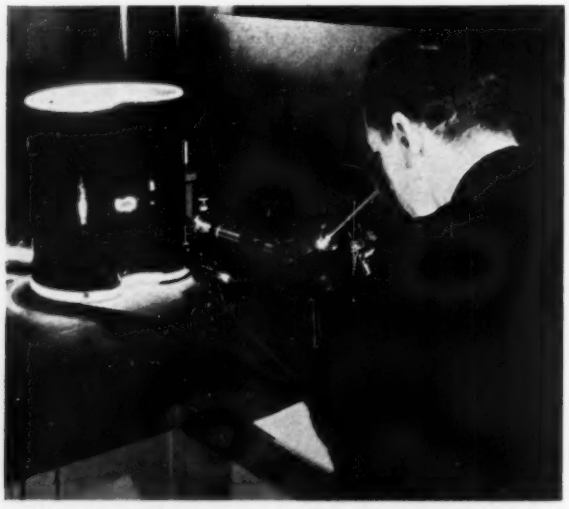
Optical Characteristics of Glass Are Controlled and Modified by Modern Methods to Meet Special Needs

By Harold R. Moulton

TRANSPARENCY and refractivity are the two properties generally dealt with when optical characteristics of glass are under discussion. The property of transparency, or ability to transmit radiation, is one whose extent must be specified, since no glass is perfectly transparent to all radiation. For example, ordinary clear glass, as limpid as water, is as opaque as a piece of metal to radiation of wavelength shorter than about 3,000 angstrom units — that is, in the ultraviolet region of the spectrum. Its transparency down to this region is greatly affected by traces of certain impurities.

In the infrared, or longer-wavelength region, the transmission is irregular, and here too it is influenced greatly by traces of impurities. In fact the presence of some substances, notably ferrous iron, may be determined with a fair degree of accuracy by a study of the transmission curve in this region.

The earliest glassmakers would have been delighted if the crude glass they produced had been clear and colorless. In view of the raw materials and methods of manufacture at their command, however, such a result was impossible; hence their use of carved rock-crystal for *objets d'art*. The subsequent discovery that the addition of certain minerals to the batch would produce colored glasses was a step forward but, even so, the variety of colors was limited, blues predominating. With the passage of centuries, a great body of empirical knowledge was accumulated and, incidentally, held very secret. The Venetians punished by death those who divulged, or sought to divulge, the methods of their glassmaking art.



Visual spectrophotometer used to obtain data for plotting visual transmission curves

With the growth of chemical knowledge and the increasing availability of raw materials, great strides were made in the development of glasses of controlled transmission. The first advances were in variety of color. Batch composition and melting procedure were found to influence the results obtained, and by ingenious rule-of-thumb experimentation considerable improvement was obtained in colored glasses. Modern colored glasses are, in effect, designed for the transmission desired — by the use of a wide variety of coloring oxides or other compounds, by modification of the glass composition, by careful control of the melting conditions such as temperature, time, and furnace atmosphere, or by all three combined.

Reproducibility is of the greatest importance, and chemical analysis of all raw materials is a prime requisite in the manufacture of glasses of controlled transmission. Because of the marked influence of small quantities of impurities, analytical procedures of the greatest refinement are necessary. Since titanium, chromium, vanadium, manganese, iron, cobalt, nickel, copper, silver, uranium, cadmium, selenium, and the rare earths are used as glass colorants, the demands upon the analyst are heavy.

All these coloring agents are affected more or less, sometimes a great deal, by relatively slight changes in glass composition, so that extraordinary pains must be taken to insure uniformity of this factor. At the same time, the variation in coloring effect with change in glass composition enables the glass manufacturer to obtain a wide range of colors and transmissions with a limited number of coloring ingredients. Likewise the melting cycle has a great deal to do with the color, other things being held constant: Reactions may be accelerated or retarded, allowed to go to completion, or stopped while still incomplete. The rate of cooling affects some colors considerably, as does subsequent heat-treatment. For example, batches containing cadmium sulphide, when suitably melted and cooled, result in a pure yellow glass. Too rapid cooling produces a glass which is nearly colorless but one in which subsequent reheating and relatively slow cooling develop the pure yellow color desired. Protracted heating in a certain range leads to muddiness or even complete opalescence.

By using iron compounds, usually excluded rigorously from commercial glass compositions, and by melting with reducing agents or in a reducing-furnace atmosphere, Sir William Crookes — the English physicist

Pulfrich refractometer used for measuring index of refraction and dispersion

whose death occurred in 1919 — found that glass was produced which had the property of greatly lowering the transmission of the near-infrared radiation, that is, radiation of wavelength greater than 8,000 angstrom units. Such glasses, containing iron compounds in the ferrous condition, are bluish in color because they selectively absorb the red. Controlling the amount of reduction makes it possible to minimize this red absorption while still maintaining the infrared absorption; part of the iron is in the ferrous state and part in the ferric state. A glass so treated is olive green, with its peak of transmission at 5,500 angstrom units, the same wavelength to which the eye has maximum sensitivity. The transmission curve is symmetrically disposed on both sides of this point, and color distortion is minimized. By the addition of about 3 per cent of a cerium compound, the ultraviolet transmission is also greatly reduced.

The use of cerium compounds in glass to effect reduction of ultraviolet transmissions was also started by Sir William Crookes. In his time, commercial cerium compounds contained neodymium, praseodymium, lanthanum, and other rare earths as impurities. Consequently glass compositions containing such crude cerium possess the characteristic absorption bands of neodymium and have a lilac-gray tint. Such glass, used for eyeglass lenses, is called Crookes glass. Pure cerium, which has since become readily available, has practically no coloring effect in itself but does have ultraviolet absorption. Other coloring ingredients, as desired, are incorporated to reduce the visible transmission or to produce a distinctive color. One of these glasses, for example, is of a pink or flesh tint to make it cosmetically pleasing. The pink color is obtained by the use of manganese. In general, glasses containing manganese are unstable to ultraviolet radiation and darken in color. By use of suitable glass compositions, however, it is possible to produce glass of this type which is extremely resistant to "solarization," the term applied to a change in transmission resulting from exposure to sunlight or to ultraviolet radiation.

The glasses previously mentioned have been mostly of the usual crown-glass type, containing silica, soda or potash, lime, and minor quantities of alumina, magnesia, and so on. For certain colors — such as pure reds and blues — more complex, unusual glass compositions are used, containing large proportions of barium, boron, and similar materials. In such glass compositions, chemical stability is a limiting factor, since the resulting glass must have not only the desired color but chemical stability as well, a result difficult to obtain.

Industrial developments such as arc or flame welding, high-temperature furnaces, and the like, have made necessary the use of very dark eyeglasses transmitting as little as 0.001 per cent of visible radiation. Twenty-five years ago a welding glass, however dark, which transmitted less than 25 per cent of the total energy of a high-intensity source, was a rarity. Now transmission of 0.01 per cent of total energy would be considered high in the better glasses. Welding glasses must also be strong absorbers in the ultraviolet, in which welding arcs — especially those of high amperage — are very rich. By use of glass compositions containing as much as 9 per cent iron oxide, suitably balanced between ferrous and ferric iron compounds, the harmful infrared and ultraviolet radiations are reduced to the desired extent — an amount less than that of visible light transmitted.

But these requirements are not all. In order to insure satisfactory vision of the welding operation, the blackbody radiation characteristics of the metal and slag of the weld must be taken into account, and the transmission of the glass in the visible region of the spectrum should be such as to make the best use of the light from

Photometer for measuring total visual transmission

the weld itself. The result is achieved by balancing the relative amounts of ferrous and ferric compounds. It should be noted in passing that iron itself becomes one of the major constituents of the glass batch and that the composition must be varied in such a way as to compensate for it.

THE other optical characteristic of glass is its refractivity, or light-bending power, a property obviously important in optical design. The light-bending property is a result of the variation of the velocity with which light is transmitted; and the index of refraction, or refractivity as generally used, is the ratio of the velocity of light in air to the velocity of light in the glass. The change in velocity at the boundary of the glass causes, for oblique beams, a bending toward the normal to the surface at the point of incidence. The angle between the normal to the surface and the incident ray is the angle of incidence; the angle between the normal and the refracted (or bent) ray is the angle of refraction. Snell's law states that the ratio of the sine of the angle of incidence to the sine of the angle of refraction is a constant, known as the index of refraction for the substance.

The index of refraction varies with the color (or wavelength) of the light. It is generally measured for light of wavelength 5,893 angstrom units, the mean of the D lines of sodium, and the index is then referred to as "n_D." (Water, for example, has the value 1.3334; benzene, 1.50; methylene diiodide, 1.74.) To express the variation of index with the color of the light, the index is customarily measured at wavelengths 6,563 angstrom units (C line, red) and 4,861 angstrom units (F line, blue); the term *nu* (ν), or reciprocal relative dispersion, is applied to the result of the subtraction of 1 from the index for the D line and the division of the result by the difference between the refractive indexes for the C and F lines. This value, in general, ranges from 20 to 75 for glass, depending upon the composition. The higher the *nu* value, the greater the compression of the spectrum; the lower the *nu* value, the greater the spread of the spectrum, because of the greater variation of refractivity with the color of the light.

The two simplest methods of measuring index value make use of a microscope. If powdered glass is immersed in a liquid of known refractive index and examined under a microscope, the index of the glass may be rapidly estimated. A series of liquids of known indexes is used, and the index of the liquid in which the glass particles most nearly disappear determines the index of the glass. This method is commonly used by petrographers. The accuracy is ±0.002 under the best conditions.

Another microscopic method makes use of the fact that the apparent thickness of a flat piece of glass depends upon the index. Through an alternate focusing on the lower and upper faces of the piece, the apparent thickness can be measured. By means of a micrometer the actual thickness is ascertained. The measured thickness divided by the apparent thickness gives the index of refraction. The accuracy by this method is about ±0.01.

Two types of commercial instruments are in general use for index measurements. Both depend upon the measurement of the angle of total reflection. The first of these is the Abbe refractometer, which reads index directly upon a graduated scale. The specimen, ground and polished flat on one side, is placed with that surface against a prism of high-index glass; a contacting liquid of index higher than that of the unknown glass is placed between the specimen and the instrument prism. (If the liquid is of index lower than the specimen, the index of the liquid will be measured.) The accuracy is about ±0.0002. Dispersion, or *nu* value, is read to an accuracy of about ±0.5 by means of a simply manipulated attachment. (*Continued on page 50*)

THE INSTITUTE GAZETTE

PREPARED IN COLLABORATION WITH THE TECHNOLOGY NEWS SERVICE

Will It Help to Win?

President Compton Reports to the Corporation on the Institute's Record in War Work and Education

CRITERION for all effort, planning, and policies at the Institute during the past year, President Compton declared in his annual report to the Corporation, has been the question: "Will it assist our institution in making its maximum contribution now to the winning of the war?"

"We have sought," Dr. Compton said, "to apply this criterion — and I speak for students and staff alike — without regard to self-interest, expediency, or stress, in the belief that the Institute community would be doing less than its share if it fell short of the maximum responsibility and effort of which it is capable."

Two major topics in President Compton's summary of the record of the Institute as it stood in October, in the eleventh month of the war, were Technology's direct war activities as such and the changes and trends that have been brought about in normal operations as a result of the special demands which are imposed by the present emergency. Surveying the general picture of Institute affairs in opening his report, Dr. Compton said:

. . . The role of the Institute is very significant indeed, as measured by any yardstick. In terms of budget, our special war operations are running over three times the rate of the Institute's normal peacetime budget and continue to increase. The teaching and research staff have been more than doubled. During the past year, the total enrollment of students has increased about 50 per cent above normal because of the establishment of special war-training courses, and during the coming year these special students will equal our normal enrollment. To accommodate these activities, we have not only crowded our regular laboratories and classrooms to the limit but have built since the beginning of the emergency one small and two large permanent buildings and one very large and two small temporary buildings; have added temporary stories on top of the George Eastman Research Laboratories; have purchased two near-by industrial buildings; have rented large space adjacent to the Boston Harbor, a Cambridge industrial building, part of a shore estate in Rhode Island, a commercial hangar at the East Boston airport; and have received from the Commonwealth of Massachusetts the loan of its fine hangar facilities at the same airport — thus adding all told some 435,000 square feet, or ten acres of floor space, to our plant for the duration, in addition to devoting some 73,000 square feet of regular plant to war activities. All of this has been done without publicity and without confusion — but not without strenuous effort, since the war program is superimposed upon an educational program operating to date at normal level and with reduced teaching personnel.

Acme

President Compton with President Conant of Harvard and Bernard Baruch — the three men chosen by President Roosevelt to work out an answer to the nation's rubber problem — as they went to work in Washington in August with Mr. Baruch as chairman

. . . *War Activities* . . .

With this over-all picture in mind, let me turn now to specific details of our war operations in terms of man-power contributions, educational activities, and research. The regular Faculty and staff have accepted the duty of leading the Institute to war. At present 55 have been given leave to accept war assignments and of those remaining at the Institute, 160 are engaged full or part time directly on war work. . . . By the end of this year, the Institute will have contributed staff time to the war effort which, measured in terms of salaries, totals $400,000. . . . I think it is fair to say that our organization is working effectively and with a fine spirit, and with a division of labor which permits some to take the more spectacular posts while others fill those which are less exciting but equally essential in making up an entire co-ordinate war effort.

The intensive training of technical experts has been administered most effectively on a national scale under a division of the United States Office of Education, now called the Engineering Science and Management War Training Program. The Institute has co-operated with other colleges in metropolitan Boston in providing a well-balanced and well-divided program to meet the most urgent requirements on the part of both industry and the government for technically trained men and women.

During the year ending October 1, fifty-two courses extending over periods from four to sixteen weeks have been given by the Institute to 2,061 students. . . . Of this program the largest course (actually it is a small institution in itself) provides training to about 2,200 army and navy officers a year in ultrahigh-frequency radio techniques. These officers come in groups of about 200 a month, each group staying for three months. In the same field we have given two courses designed to equip instructors in physics and electrical engineering from other colleges and universities to offer special instruction to college students in ultrahigh-frequency techniques. Over 60 institutions have sent instructors here to take this work under the direction of Wilmer L. Barrow, '29, Associate Professor of Electrical Communications. Two conferences have likewise been held, with the collaboration of the Army and Navy, to permit these instructors jointly to prepare a standard syllabus for the courses offered by the colleges.

In order to facilitate the purchase of special equipment needed in these courses, the Institute, at the request of the Office of Education, has acted as a central purchasing agency for all

I cannot speak in too high praise and appreciation of the very able manner in which this special training program has been conducted under a committee headed by Professor Raymond D. Douglass, '31. Over 60 regular members of our staff have given the courses, largely as an overload, together with 81 other instructors drawn from elsewhere, including the Army and Navy. During the current year, training will be given to about 3,000, a total equal to the regular enrollment of the Institute.

In addition to these government-sponsored courses, we are continuing to offer other programs for military personnel as a part of our regular curriculum. A nine months' course in meteorology for 130 army, navy, and weather bureau representatives will be completed on December 1 and will be repeated again beginning in January, with an expected enrollment of 350. We also continue to train postgraduate naval officers in torpedo engineering, fire control, naval construction and marine engineering, naval engineering, and aeronautical engineering. To supervise the officers detailed here and to act as liaison officer between the Navy Department and the Institute, the Navy has assigned here Captain C. S. Joyce as senior naval officer, and I wish to pay tribute to his wise administration of navy activities.

Our major contribution to the war effort continues to lie in the field of research. When I reported to you a year ago, our number of research contracts with government and with industry totaled 55. Despite our rigid policy of refusing to undertake additional projects unless they are of first priority and unless no other arrangement for the prosecution of them appears feasible and comparably favorable, the number has now increased to 99, of which a third are for the Office of Scientific Research and Development. At this time last year the personnel engaged in this work numbered 466. This figure now stands at 1,800, of which nearly half are scientific personnel and half accessory personnel such as clerical staff, guards, and mechanics. Of this scientific personnel in war research, about 10 per cent are part-time workers from our own staff, a majority of whom contributed their time. Of the full-time staff numbering around 800, about 3 per cent have been drawn from the Institute staff. The remainder have come on leaves of absence from 73 educational institutions and 43 industrial organizations.

A program of this magnitude and widely representative staff is clearly a national undertaking, a group effort on the part of American colleges and universities with the Institute acting as host and providing management and services. This is notably true of the largest of the projects, which is almost wholly administered and staffed by able scientists lent by other institutions in response to requests from the Office of Scientific Research and Development. Although our principal research project for the O.S.R.D. is a co-operative group-undertaking, the Institute has carried the contractual responsibility of managing and financing the work, with all attendant risks and strenuous adjustments. This has given us much concern because of the size of the project in relation to the Institute's financial resources, but I can report to you now that with the assistance of able legal counsel and rigorous auditing we have negotiated revised contracts which provide maximum protection against all foreseeable contingencies, which require a minimum use of Institute funds, and which are designed to leave us without profit or loss on the operations. . . .

Many developments of importance have come from the research work carried on in our laboratories. I cannot discuss these in detail, but I can say that equipment designed here has already been used successfully against the enemy and is being procured in very large quantities by the armed services.

. . . *Changes and Trends* . . .

In contrast to the last War, it has been a recognized national policy so far in this one to maintain, expedite, and increase the education of young men and women in the sciences, engineering, and medicine. If we knew certainly that the crisis of the war would be passed in 12 or 18 months, sound policy would dictate calling out from our educational institutions every available man to throw into a mighty effort. We have no assurance, however, that victory will come that quickly, and consequently it would be a very shortsighted policy to cut off too soon the training programs which can most efficiently provide technical talent, of which there is an enormous shortage, to our industries and armed forces.

The Institute has been governed by this point of view in adjusting its educational program to war conditions. Our first move was to speed up the program of the Class of 1942, with some curtailment of nonprofessional subjects, to permit graduation on April 27, over a month in advance of the normal date. Last January the Faculty voted and the Corporation approved further changes for the war period, which included:

(*a*) Starting the first term for fourth-year students in June, immediately following the close of the second term of their third year, with graduation in February.

(*b*) Requesting undergraduate students to obtain employment contributory to the war effort during the summer periods

when they were not engaged in academic work, and requiring them to submit to their registration officers on registration day of the fall term a report describing the duration and type of summer work engaged in by them.

(*c*) Making a special effort to accommodate freshmen beyond the normal limitation of about 600 to the extent that there are increased numbers of applicants with superior qualifications and within the limitations consistent with good performance as imposed by available staff and laboratory space.

(*d*) Continuing with increased emphasis the practice of permitting qualified students to anticipate subjects or to take advance-standing examinations in subjects in which they have not been enrolled, thus expediting their completion of graduation requirements.

Our experience thus far with this program has been satisfactory. Only a few of the Class of 1943 failed to attend the senior summer term, and the records of the Class were good, indicating that this limited acceleration has not perceptibly injured performance and development, as a more extended speed-up plan might have done in the intensive kind of professional education offered by the Institute. We had gratifying success in placing students in war industries during their summer vacations; all members of the sophomore class and a high percentage of the freshman class obtained employment or attended summer school. . . .

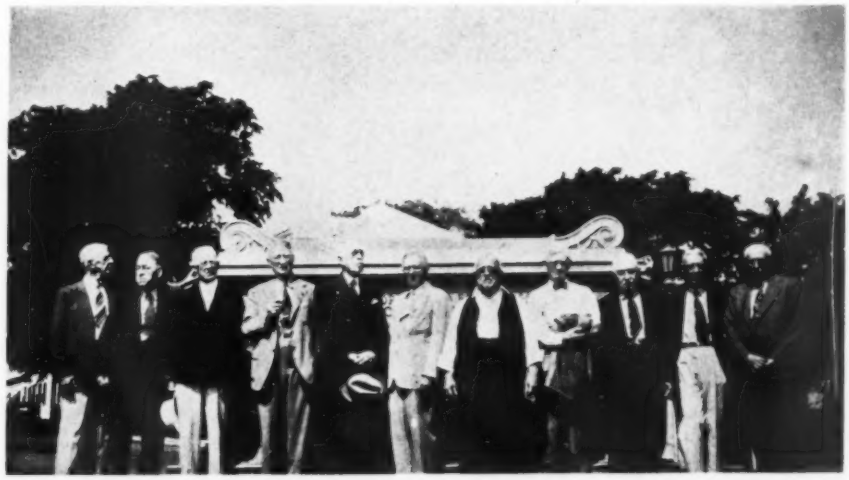
Under the provisions of the Selective Training and Service Act, the Institute has continued to assist members of the junior and senior classes in requesting deferment if they are preparing for work in essential occupations, if they are in high standing at the Institute, and if they show promise of making a significant contribution to the national welfare. Thus far the Selective Service program has been administered from Washington and by the local boards in a manner which has given recognition to the importance of advanced technological training. Selective Service headquarters have continually emphasized the need for technically trained personnel, and all of the scientific and engineering aspects of the Institute's curriculum have been included in the category for which provisions have been made to permit qualified, regularly enrolled students to continue their programs.

The Institute has further sought to aid its students in preparing for service by participating in the Enlisted Reserve Corps plan of the Army, which provides for insuring a future source of qualified officer candidates for the Navy and Marine Corps as well as the Army. Both the Selective Service program and the reserve plans of the Army and Navy have posed many problems for students, and we have tried to help them in reaching personal decisions by announcing to them through convocations and frequent bulletins the latest and most complete information available. We have also appointed special advisory officers to assist students and staff on problems relating to military service. . . .

Although our actual experience to date with the draft boards and the armed services has been encouragingly satisfactory, we and all other educational institutions have reason to be concerned over the outlook for the future. In the last three months national policy on man power has become less coherent, and college students particularly have been left without any clear directive as to what their course should be. In September the Secretary of War announced that all students in the Enlisted Reserve should expect to be called at the end of the term during which they reached draft age, thus reversing the implied policy of the reserve plan when it was announced last May. Within a few weeks the Secretary of War in another communication said: "My statement . . . has been interpreted in some quarters to mean the end of all higher education for the duration of the war. This is a misapprehension that should be corrected. The Army is greatly in need of men of specialized training in physics, chemistry, engineering and medicine. . . . It is hoped that colleges will maintain their training of students in engineering, medicine and other sciences."

Except to say that new plans were being developed for the training of those inducted into the Army, the statement gave no indication of how students in science and engineering, particularly freshmen and sophomores who cannot be deferred under draft regulations, may secure advanced scientific training after reaching draft age, whether it be 20 or ultimately 18. In late August a report of the War Manpower Commission stated that all able-bodied students are destined for the armed forces and that students should recognize that the exigencies of war do not permit any assurance that they may remain in college for any specified time. Meanwhile a limited number of students in the Navy's V-1 and V-7 programs can remain in college until the completion of their college program, unless called earlier to active duty.

The lack of definite planning evident in this brief chronology of recent moves (other confusing expressions of policy could be cited) has left the science and engineering student in an equivocal position which is unfair to his demonstrated desire to serve his country in the most effective capacity. The colleges, moreover, are left without any discoverable educational directive as to their responsibility or national duty. Our war effort is certain to suffer if the man-power policies of the gov-



M.I.T. 1887 at its 55th reunion, held at Plymouth, Mass., in June. From left to right, those pictured are N. P. Ames Carter, Lonsdale Green, Nathaniel T. Very, Richard E. Schmidt, Winthrop Cole, Julian A. Cameron, Albert L. Cushing, Philip A. Mosman, Frederick A. Kendall, Frank F. Tripp, and Herbert A. Wilcox. Unable to be present were Charles A. Barton, Giles Taintor, George F. Sever, and Franklin Brett.

ernment are not quickly co-ordinated and clarified. With respect to technical students, there are several possible alternatives:

(1) Induct them all into the military services immediately upon their reaching the age for military service. This would mean cutting off the new supply of technically trained men in the face of an increasingly critical shortage of them both in the armed services and in industry. I believe that high strategy could wisely dictate so violent a course only if it were practically certain that the war could thus be won before these men would otherwise have become trained and available for technical service. But it would involve a huge risk if the war should last several years and thus strain our technological resources to the utmost.

(2) Induct all able-bodied students into the armed services and assign qualified ones back to colleges for scientific training with expenses paid. This would mean that any young man, regardless of his financial resources, would have an opportunity, if he were qualified, to be given advanced training in accordance with the needs of the country. In the light of present shortages, this would seem clearly preferable to (1).

(3) Establish a civilian reserve into which young men qualified for scientific training could be inducted for the purpose of being trained for work in essential industries or in the military services. Upon completion of their training they could be assigned to either industry or military service in accordance with their capacities and the needs of the situation.

(4) Continue the present reserve plans and draft policies but co-ordinate them, intelligently and courageously provide for deferment only in those fields of training where critical man-power shortages exist, clearly establish the student's responsibility and duty and the importance of his service as a student, and indicate the type and duration of the program which the colleges should provide for him.

The acute necessity is to adopt *some* consistent plan so that the institutions and students may drive vigorously toward its objective. My own experience with the scientific program of the government and the technical problems of the services and of industry convinces me that cutting off the continued supply of technically competent men would be a national calamity, in that we should soon experience disastrous shortages of adequately trained personnel for the production and operation of the necessary huge arsenal of new weapons.

Fiscal 1942

TECHNOLOGY'S financial operations for the fiscal year 1942 — summarized by Horace S. Ford, Treasurer, at the October meeting of the Institute's Corporation — concluded successfully, notwithstanding some unusual features introduced by the extensive programs of wartime research which were in progress during the year. The book value of endowment and other funds of the Institute reached a total of $37,300,000 as of June 30, an increase of $1,300,000. Plant assets increased $330,000, the total value standing at $17,000,000.

Significant changes in the investment of Institute resources include a reduction from 37.5 to 34.4 per cent in bond holdings, from 21.3 to 19.4 per cent in United States bond holdings, from 4.6 to 3 per cent in preferred stock holdings, and from 43.5 to 39.8 per cent in common stock holdings. Real estate holdings and cash operations have comparably increased. The market value of the general investments of the Institute as of June 30 was 91.5 per cent of book value. (As of October 9, this percentage approached 96.) Yield on all investments at market value was 4.22 per cent as compared to 4.36 per cent for the fiscal year of 1941. Income available to the Institute for distribution to its pooled funds fell off $72,000 to $1,049,000 for the year.

Total operations for educational and general purposes for the year were about $400,000 in excess of the figure for last year. Educational expenses were almost identical with those for fiscal 1941, but general and special administrative expenses showed an increase.

Operations of the Technology Loan Fund, to be more fully reported in a subsequent issue of The Review, were unusually satisfactory. This year for the first time repayments on loans exceeded the new loans made. Activities of the M.I.T. Pension Association were similarly satisfactory, as were the operations of undergraduate and graduate dormitories, their associated dining services, and the Technology Photographic Service. This last service, which was started in 1925 as a minor venture with the part-time assistance and interest of a single instructor in physics, now occupies 12 bays of space in the basement of Building 11 and employs the full-time services of 11 people.

Alumni Day Plans Afoot

MEETING in January chill rather than June blandness, M.I.T. Alumni will nevertheless maintain "the fellowship of spring" by preserving the custom of Alumni Day and the Stein-on-the-Table Banquet as usual despite shifts of schedule. Festivities are arranged for Saturday evening, January 30, at the Hotel Statler in Boston, to precede commencement exercises for the Class of 1943, planned for Monday, February 1.

D. Walter Kendall, '24, chairman of Alumni Day 1943, has announced chairmen of various committees as follows: ways and means, Horace S. Ford; registration, Donald P. Severance, '38; dinner, Herbert R. Stewart, '24; publicity, Ralph T. Jope, '28; ladies' events, Mrs. Leicester F. Hamilton; Class Day, John D. Mitsch, '20. The stein this year has a design appropriate to the occasion, the work of Henry B. Kane, '24.

Plans for their customary five-year reunions have already been set up by a number of classes and are presented here. As further arrangements for Technology's annual celebration are perfected, they will appear in subsequent issues of The Review.

. . . *Class Reunions 1943* . . .

The reunion plans for the present academic year show a considerable spread, some classes proposing to meet in the traditional Junetide, others making arrangements for their reunions to coincide with 1943's heterodox January Alumni Day. Plans as of October 15 are summarized below:

1883, Harvey S. Chase, Secretary. No reunion is planned.

1888, Bertrand R. T. Collins, Secretary. A reunion is expected to be held in June; announcements will go out later.

1893, Frederic H. Fay, Secretary. Frederick N. Dillon has reported plans for a reunion on June 5, probably at The Country Club, Brookline. Further details should be obtained from the Secretary.

1898, Arthur A. Blanchard, Secretary. Ernest F. Russ, chairman of the reunion committee, reports that plans for the present call only for a meeting in Boston on Alumni Day,

with luncheon in Room 403, University Club, at 1:30 P.M. on Saturday, January 30. Sociability and special '98 features will fill the afternoon program at this meeting place, with adjournment to the Hotel Statler for the Alumni Day Banquet. If war conditions change, the usual three-day reunion will be held in June.

1903, Frederic A. Eustis, Secretary. Plans for the fortieth reunion call for sessions in June at some seashore point, preferably between Boston and New York. At the class dinner to be held in Cambridge or Boston about January 30, the proposal will be discussed.

1908, H. Leston Carter, Secretary. Thirty-fifth reunion is to be held at the Oyster Harbors Club, Osterville, Mass., June 18 to 20 inclusive. Present conditions make plans more or less tentative.

1913, Frederick D. Murdock, Secretary. Present plans call for a gathering at the Hotel Statler on the afternoon of Alumni Day, January 30.

1918, Gretchen A. Palmer, Secretary. Twenty-fifth reunion is definitely planned for June, probably over the week end of June 20, somewhere between Boston and New York. Headquarters on Alumni Day, January 30, are to be established at the Hotel Statler or some other convenient location.

1923, Horatio L. Bond, Secretary. No plans have as yet been made for the regular five-year reunion, but it may be assumed that one is to be held.

1928, George I. Chatfield, Secretary. The matter of a June reunion is to be discussed at a get-together in the Hotel Statler on the afternoon of Alumni Day, January 30.

1933, George Henning, Jr., Secretary. No decision has been reached concerning a reunion in June. A get-together is planned for Alumni Day, January 30, perhaps at the Hotel Statler.

1938, Dale F. Morgan, Secretary. A class get-together will be planned on the Sunday following Alumni Day, with dinner in Boston or Cambridge or at one of the near-by country clubs. More definite plans are to be announced later.

Alfred H. Schoellkopf, 1893–1942

ALFRED H. SCHOELLKOPF, '15, a term member of the Institute's Corporation since 1940, died in New York on June 9. Mr. Schoellkopf, who was 49 years old, was one of the most active leaders in the public utility field. He had been associated with the Niagara power system since 1915 in various executive capacities and was elected president of the Niagara Hudson Power Corporation in 1933. He also held the important post of chairman of the board of the New York Power and Light Corporation.

Before going to New York City, Mr. Schoellkopf gave much time to social service and civic organizations in Buffalo, and in 1933 Governor Herbert H. Lehman appointed him chairman of the temporary emergency relief administration of the state of New York, a post in which he served until 1935.

In addition to his responsibilities as head of one of the country's great power systems, Mr. Schoellkopf had served as chairman of the state board of social welfare of the state of New York and president of the Welfare Council of New York City. He was a member of Delta Kappa Epsilon, the Academy of Political Science, the Adirondack League Club, the American Museum of Natural History, as well as the Buffalo Society of Natural Sciences and the Chamber of Commerce of the state of New York.

Deputy Dean

NAMED deputy dean of engineering in early summer was Robert S. Williams, '02, Head of the Department of Metallurgy at the Institute. Dr. Williams has since then been assisting in the duties of the Office of Dean of Engineering during the absence of Edward L. Moreland, '07, Dean since 1938, who is serving as executive officer of the National Defense Research Committee of the Office of Scientific Research and Development. In this capacity Dean Moreland is spending the majority of his time in Washington.

A widely known authority in the field of metallurgy, Dr. Williams has been associated with the Institute as student and member of the Faculty since 1898. He has been head of the Department of Metallurgy since 1937 and has been largely responsible for the establishment of the Institute's courses and equipment in metallography, the treatment of alloys, and spectroscopic and x-ray analysis. *(Continued on page 52)*

At its summer meeting, the Technology Club of Puget Sound gathered at the home of H. W. McCurdy, '22, on Mercer Island. Shown here on the McCurdy yacht are, back row: Theodore P. Snow, '39, Edward F. Brady, '41, William R. Mason, '41, Harold K. Moritz, '21, Gustaf B. Bengtson, '20, Eugene W. Rudow, '21, Edward S. Campbell, '26, James W. Barton, '39, Gilbert J. Ackerman, '28, Vincent J. Grace, Jr., '42, George C. Morrissette, '35, Holland H. Houston, '24, and George H. Stebbins, '17; front row: Floyd A. Naramore, '07, Maurice P. Anderson, '10, Joseph Daniels, '05, Herbert Fryer, '11 Charles A. Whitney, '29, W. Scott Matheson, '99, Charles S. Pope, '27, and H. W. McCurdy, '22.

TOWARD A MODERN AESTHETIC

(*Concluded from page 24*)

From these two keyboards proceed the three categories of all possible art: (1) Works built entirely of *sympathetic* Forms. These dominate in Mediterranean and African art. (2) Works built entirely of *antagonistic* Forms. These are rare — a few Asiatic, Chinese, Scythian, Gothic, and dramatic romantic works. (3) Works which combine the Forms of the two keyboards in diverse proportions. These are by far the most general.

THE time has come, then, in aesthetics to cease classifying Forms according to their mode of production — nature, the artisan, the engineer, the machine, the artist — in order to decide whether they have the right to satisfy us aesthetically. A Form, no matter what its age, its price, its origin, or its use, should be regarded with naïve, unprejudiced eyes. The beautiful curve of a great dam may also be that of an egg, of a valve, of the contour of a graceful face, of a part of sculpture, of a painting, of a work of architecture. If this curve corresponds to a Preform, we ought to be able to react to it aesthetically, the intellectual or psychologic associations being greater or less, of course. We have a Preform which the curve of an egg satisfies. Proof: We eat without pleasure a badly formed egg the curve of which departs from the normal.

Without laboring the point here, I believe I can show that certain Forms, the most satisfying and at the same time the richest in psychological reactions, recur since antiquity in the masterpieces of art, as in many other things of all origins and in extremely diverse combinations or mediums. These Forms, or curves, are generally what I shall call the Forms of the universe. They are the "graphics" *visualizing* the laws of the functioning of the universe and of life, showing the laws in action.

No doubt our subconscious, which acts so much within us and upon us, seeks to find in everything that it sees and perceives an accord with everything which is and of which it feels that we are an active part. The features of a beautiful woman, the curves of a Cézanne apple, a Seurat Form, certain cubist or purist abstractions, the universal curve of a dam or of a bridge, an airplane propeller, a Gropius functional Form, the structure of a cloud rendering visible the forces of the wind, the recording of an electric drama by a Von Hippel photograph, the hyperbola of an Egyptian or Sumerian vase or face give a great deal more than a simple optical pleasure. They offer us a deep mystic emotion — which may be either lay or religious or both, according to the symbolic proclivity of each of us.

All this causes us to reflect that our Preforms could well have the same Forms as the forces of the universe.

After all, this would be *natural* enough.

THE CENTER OF THE PROBLEM

(*Continued from page 21*)

our resources, our technical proficiency, and our potential man power. It is safe to say that no war can be won without the combination of effective resources and morale which is represented by factors of this kind.

By our resources we mean, I suppose, the abundance of tin, nickel, electric power, copper, and all the other essential materials which war demands. In some respects, especially coal and iron, Germany is now self-sufficient; but Europe has no cotton, little oil, less nickel or tin to compare with the potential resources of the United Nations. Similarly, victory depends on the inventive capacity of Americans, on the ability to furnish ships, and on the strength of such industries as steel and aluminum. If Germany and Japan were as wealthy as we, the chances of ultimate victory would be dim indeed. These resources and these capacities of the United Nations, however, are potential victory and not victory itself. As we have recently discovered with rubber and tin and may discover even with oil, these advantages may be lost with surprising suddenness.

Beyond oil and tin and ships, the strongest factor in the situation is the actual or potential union of the varied populations of a far-flung struggle. A single military power with enough strength might perhaps win a war and establish peace without much regard to any theories or ideals except its own. With us, however, this is an impossibility. For better or for worse, we have entered a huge alliance. A victory will be not for ourselves alone but for half the human race.

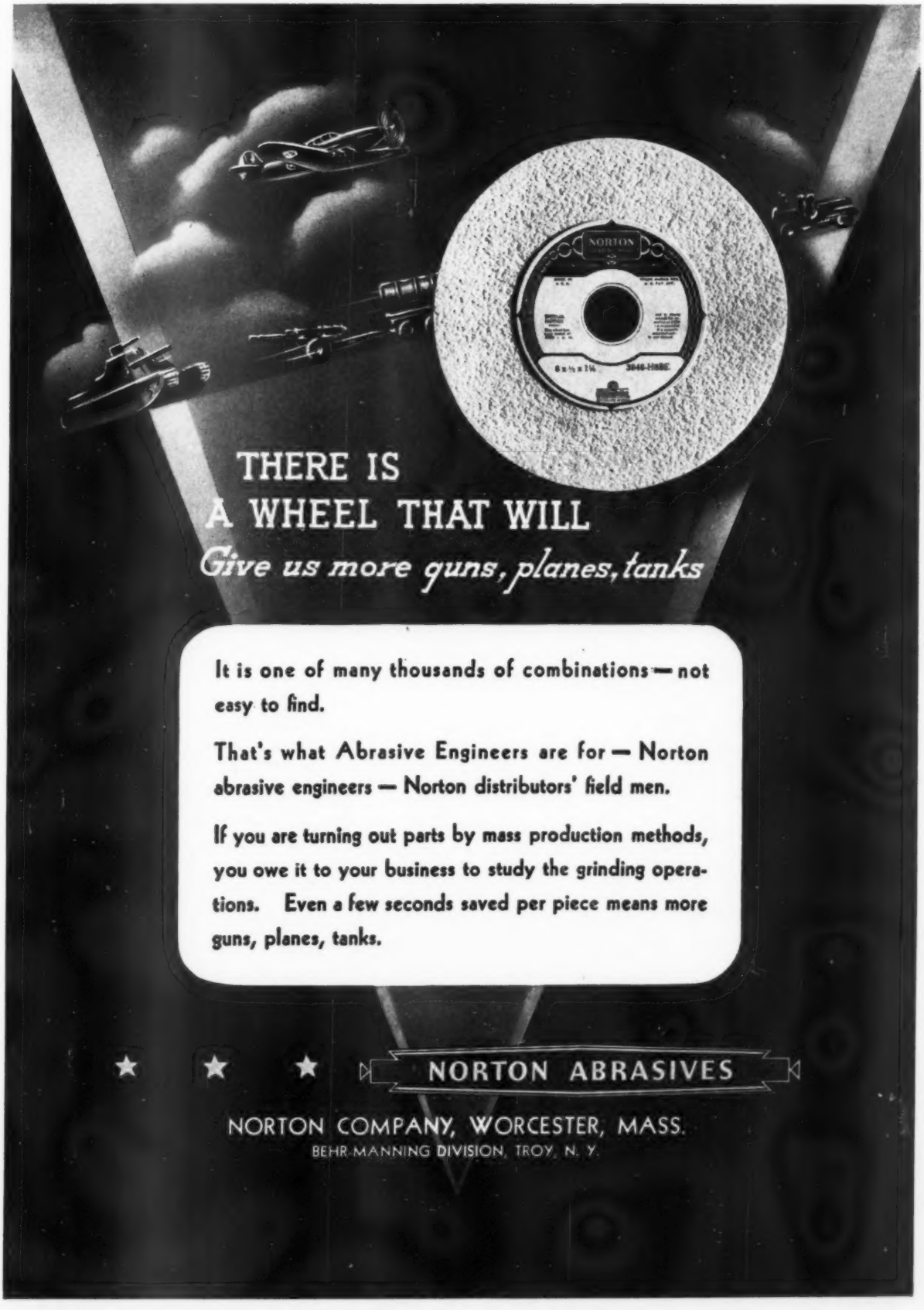
Here is a resource, both spiritual and material, which is on our side and which by indifference can also be lost overnight. At first sight, a war in which three-quarters of the people of the globe are engaged against a dangerous minority cannot be lost. Have we not today 180,000,000 Russians, 450,000,000 Chinese, at least 240,000,000 Hindus, 130,000,000 North Americans, and another 130,000,000 persons in a most strategic position south of the Rio Grande? Today these last are our neighbors — and will remain so only if they are certain that the purposes we have in view are also theirs.

The problem, then, must undoubtedly be attacked on many fronts: political first, then commercial, but also cultural. And this vast problem will remain the essential task of both the war and the eventual peace. For the union which fate has created will fall apart like a house of cards unless hundreds of millions of people — Hindus, Malays, Filipinos — come to respect, understand, and serve one another in a new spirit which shall be the very antithesis of the older imperialisms of the "white man's burden" and the new and dangerous imperialism of the Aski mark.

Real understanding and real unity of purpose must be established on a front vaster than any ever dreamed before. Misunderstandings must be removed, and hundreds of millions of men marshaled in spirit, as well as in body, for a common task. Seen in this way cultural relations, broadly conceived, are the very center of the problem.

War does strange things to the delicate fabric of cultural contacts. A portion of this process inevitably is destructive. After the last War, study of German almost disappeared from our high schools, and the effects were felt in colleges and universities for a generation. This time a promising beginning in Italian studies will certainly be retarded and curtailed. Thousands of Americans who traveled to Florence, Berlin, or even

(*Continued on page 38*)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THERE IS
A WHEEL THAT WILL
Give us more guns, planes, tanks
It is one of many thousands of combinations — not easy to find.
That's what Abrasive Engineers are for — Norton abrasive engineers — Norton distributors' field men.
If you are turning out parts by mass production methods, you owe it to your business to study the grinding operations. Even a few seconds saved per piece means more guns, planes, tanks.
NORTON ABRASIVES
NORTON COMPANY, WORCESTER, MASS.
BEHR-MANNING DIVISION, TROY, N. Y.

An Invitation to a
MACHINERY MANUFACTURER or INVENTOR

to plan with us NOW for an enlarged business AFTER THE WAR

We are one of the leading makers of machinery in our field. Our wrapping machines are now used by hundreds of concerns — in the food, drug, candy, tobacco, dairy fields, etc. Our plant is modern, and is manned by skilled craftsmen. Our engineering and designing staffs have first rate inventive ability and have been responsible for many outstanding improvements now widely used by the package goods industry. And our current designing work for the war effort comprises such new developments as a cartridge clip loading machine, a new Navy lamp, a gun sight and a designing assignment for a large steel company.

Being heavily engaged in war work—both designing and manufacturing—we have greatly enlarged our facilities. Consequently, we will be in a position to build a larger line of machinery when the war ends. In preparation for this, we are now working on ideas for expanding our regular line of machines.

But we want to do more.

We are thinking of adding other lines of machines used by industries we do not now serve.

● You may have ideas for new machinery which need development. We'll be glad to discuss them with you, and if mutually satisfactory, will develop them with you.

● You may have a machine or machines which you have been making in your own plant, but which you could make with greater profit in ours.

Our final arrangement may result in your coming into our company—or it may be worked out on some other desirable basis.

If you feel you have something on which we might work together, we suggest that you communicate with us, giving full particulars. We can then arrange for a meeting.

PACKAGE MACHINERY COMPANY
Springfield, Massachusetts

THE CENTER OF THE PROBLEM

(*Continued from page 36*)

Paris go there no more. The work of missionaries and oriental scholars in Japan seems, for the moment at least, to have vanished in the storm.

To some extent, however, war makes closer cultural relations not only desirable but even automatic and inevitable. More often than not it has served to break down petty prejudices. Consider the great conquerors. After Alexander the language, the philosophy, the marvelous literature of a small peninsula and of a few islands added the rich pattern of Greek life to alien cultures of North Africa and the Middle East. So to remote regions, hidden in the fogs of the English Coast and the forests of Gaul and Germany, the legions of Rome carried forms of cities, respect for law, and even a language which had its origins on the blue waters of the Mediterranean. The campaigns of Louis XIV established the pattern of French life which remained when victory had been forgotten in defeat; and in the realms of cultural influence, Napoleon gained victories which still endured even among the shadows of Elba and St. Helena. Truly, war, even when unconscious of its role, always serves to familiarize men everywhere with the problems, the needs, the dreams of other men who but yesterday seemed distant, alien, and uncouth.

Today the same process is evident. Thousands of Americans, including some radio announcers, can locate and pronounce Celebes and Timor, whereas yesterday these names meant little to them. Similarly, Chinese peasants have reason to know American technicians and scientists. Furthermore, the new Pan-Americanism, which has won its chief victories since 1938, is to a large degree a by-product of the war. How else can we account for the fact that such a country as Uruguay, whose exports to the United States in a typical year are only 14 per cent of its total sales, now takes the leadership in friendly assistance? In spite of distances, which are still dangerous, and despite the differences that were once the theme of Rodó, Ugarte, and Calderón, the Rio Conference marked one of the great diplomatic victories of American history, partly because 19 nations suddenly discovered common memories of independence in which each had a definite stake.

In another respect, also, the war furnishes an unusual opportunity. Generally, when we think of establishing cultural relations with other nations, we have to go across the sea. Today, the bitter events of the past few years have sent hundreds of leaders of exiled cultures to our own shores. New York is already a great center of French culture. Many leading scientists and thinkers from Germany and Italy live in the United States. Those who are familiar with the foreign groups which have passed one or two generations in the United States all testify that, for the most part, they combine a sincere interest in the cultures which they left behind with a deeper appreciation of the value of free institutions than do many of us who have known no other way of life.

This result is natural when we think of conquered peoples — the French, the Norwegians, the Danes, the Czechs, and all the rest. But the same situation applies

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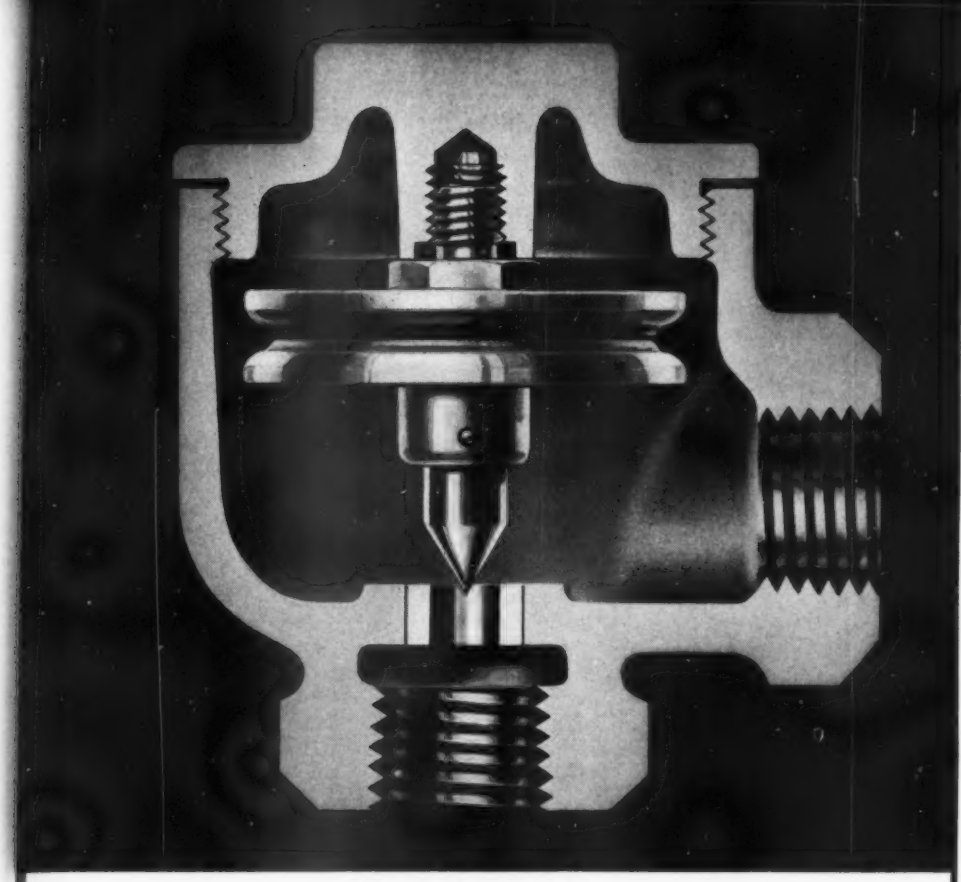

Webster 702HF Radiator Trap.

To Save Critical Materials

"Old Ironsides"

It took months of planning . . . But, Webster Engineers are ready with the "Old Ironsides" line of radiator traps and valves conforming with the simplification program of the War Production Board. Cast iron bodies and bonnets. Female inlet and outlet connections. Three sizes of traps—½" for 200 sq. ft.; ¾" for 400 sq. ft.; ¾" for 700 sq. ft. Two sizes of valves—¾" and 1", both in angle body—with wheel handle standard; with lockshield handle for institutions. The traps employ the time-tested Webster thermostatic element, a double diaphragm of phosphor bronze fully compensated for pressure. The valves use the proven Webster mechanism, fully meeting the specification for spring-retained packing . . . The "Old Ironsides" line uses the minimum of critical materials; saves machine-tool hours for direct war work; keeps steam available for heating war production plants, Army hospitals, etc. "Old Ironsides" traps and valves will be available on appropriate priority.

Essential repairs for existing Webster System installations are available to our customers on A-10 priority, under provisions of Emergency Plumbing and Heating Repair Order P-84 of the War Production Board. Orders should be limited to actual repair needs.

WARREN WEBSTER & COMPANY
CAMDEN, N. J., EST. 1888, PIONEERS OF VACUUM STEAM HEATING

LEAN, savage warbirds . . .

60 thousand in 1942 . . .

125 thousand in 1943 . . .

That is America's promise to the Victory Program—and America is going to beat that promise.

It calls for new construction at record-breaking speeds . . . mile-long bomber plants, the largest in the world.

Heating problems presented by the new building program depend for their solution on the heating lessons learned in peace-time.

Fifty years of experience taught America the practical economy of Webster Systems of Steam Heating. Built around all the natural advantages of steam as a heating medium—flexibility, speed, safety. Used successfully in more than 75,000 buildings.

That is why architects, engineers and heating contractors working on war construction depend on Webster Systems of Steam Heating.

While Ordnance production has the first call on our facilities, we are working day and night to make sure that Webster Steam Heating Equipment is available for use wherever it will help the war effort.

Let our experience serve you now.

Warren Webster & Company, Camden, N. J.
Representatives in 65 principal Cities

Webster
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This is one of a series of advertisements that will tell the public of the part that Webster Steam Heating and the Webster organization plays in the war effort . . . appearing regularly in leading business, industrial, engineering and technical publications.

THE CENTER OF THE PROBLEM

(*Concluded from page 38*)

even more strongly to Germans and Italians who do not admire Hitler or Mussolini, and to the great majority of those Americans whose fathers lived in Bulgaria, Rumania, and Hungary. Whereas every country in Europe has minority problems of the gravest kind, whereas even in the Argentine, Brazil, and Chile the German colonies are regarded with grave forebodings, the United States of America remains today the first great nation since the days of the Roman Empire which gathers strength from diversity and symbolizes the unity that lies in freedom.

A cultural program in these days of war would miss the central feature of our institutions if it failed to recognize the challenge of this situation. We are not a single master race. We may speak English, we may be heirs to a great literature, but even in our legal concepts we are also heirs to all the ages and — as Whitman saw — in the rich variety of the abounding West, we are English and Scotch and German and Dutch and Irish and Italian and Slav, and just because we are all these and more, we are Americans. Hence at a time like this, our schools should study comparative literature as well as English, and the varied origins of a great free people should make us appreciative of diversity. Unity which is not based on such appreciation must, for us, spell defeat and disillusionment.

Another opportunity which the war has forced upon us lies in the Far East. By good fortune rather than by any special virtue, our relations to many people who may now prove to be strategic have been through education or medicine, not by the ordinary methods of imperialism. When we have gained special privileges, as in the treaty ports of China, they have often been obtained without bitterness, as the mere corollary of concessions previously secured by others. The wise use of the Boxer indemnities for scholarships added to real American prestige throughout the East. There have, of course, been other less satisfactory incidents: Exclusion of Chinese, for example, now needs to be modified and corrected. The older attitude toward the negro, now rapidly changing, is resented in a world where the great majority are yellow or black and not white. On the whole, however, the American is regarded with a confidence and admiration which establish foundations for reciprocal cultural relations.

As to methods, a cultural program is full of varied details — scholarships, visits of technicians, books, music, exhibitions — no item singly important, some capable of ridicule, but all of them, when wisely chosen, fitting together like the pieces of a puzzle. Here the debate rages. Some who desire the downfall of Hitler still admire the technique of propaganda of which *Mein Kampf* was the classical expression. Fortunately, however, others now realize that at least in South America after 1936, direct German propaganda produced very disappointing results. And that outcome is natural enough, for the glorification of one race and people to the implied discredit of all the rest, which may be useful at home, can scarcely win friends abroad. If the essence of democracy is tolerance, then a cultural program which makes us familiar with a wide variety of ways of life is not only the first task of a great democracy in peace but one effective line of defense in war.

Cultural relations imply appreciation of what is beautiful and true and good. We study Dante and Homer, investigate the political theories of Bolivar, examine the folkways and the land systems of the ancient Incas, invite Chilean historians and sit at their feet, send doctors with healing to millions, consider the new agricultural possibilities in the tropics, and train technicians to serve on the curving life line of the Burma Road or to improve railways in Central Asia.

But in time of war a cultural program demands not merely memories of any past, however glorious. It must be progressive, forward looking, inspired by the hope of peace which lies at the heart of war itself, ready to serve a world where natural resources are still abundant, where opportunity may yet beckon, where justice may take new forms, where the common man may find less to weaken and discourage him, and where governments may gradually improve not alone in structural detail but also in the broad social objectives toward which they trend. For with any of us, democracy remains forever a half-completed ideal toward which we work, a direction in which we move, and, only in some distant future, a goal which any has perchance attained.

Though the government may lead, may furnish a part of the funds, no such program can be carried out exclusively by any agency of government. Bureaucratic treatment would kill the spirit, even while it might multiply offices and machinery. In one sense, of course, what is required is a new concept of diplomacy, whereby not a few trained diplomats, useful as they are, but a whole nation — young, even naïve — reaches out in its hour of need to others in like case.

Nor will this be a crusade. The test is not: Are you democratic? Are you socially organized in ways we should approve? Rather, it is: What can we learn from you? What strength can we gather from your experience? What help can we give? And our attitude must be governed not by the desire to obtain hidden privileges and concessions, not to mask imperialism either in America or in Asia, nor again out of mere sentimental philanthropy, but by the deep altruism of enlightened self-interest in an hour of desperate need, when the variety of the outside world is the only bulwark against the intolerable uniformity of nazi and fascist ideals.

STEAMBOAT ROUND THE BEND

(*Continued from page 27*)

Delaware River and Chesapeake Bay, and he showed great interest in several unusual engines he encountered. Among these were the rotary displacement engine used on the Baltimore steamboat *Surprise*, and the high-pressure, noncondensing engines built by Oliver Evans of Philadelphia for the *Aetna* and the *Pennsylvania*. Evans' engines used steam at over 100 pounds a square inch, an innovation which Marestier realized would promote economy and which he did not condemn as necessarily dangerous provided that boilers and engines were properly designed and built as well as skillfully op-

(*Continued on page 42*)

the Strongest Man in the World

THAT will be *you*, Johnny, just a few years from now!

Even today, Johnny, your dad, and millions like him, are doing jobs that call for the strength of a thousand strong men. But jobs which are easy with the powerful machines of American industry.

The power of these machines has made possible the comforts, even many of the necessities, which you enjoy. It's being used, all-out, to help win the war.

But tomorrow—there's where you come in! For tomorrow there will be jobs rebuilding a war-torn world, making it safer and finer than anything we have known. Jobs that will call for even more power and ingenuity and skill.

And you, Johnny—you'll do them! You'll have greater power and better tools to help you. You'll have new materials like plastics, new sciences like electronics. Scientists and engineers in General Electric are working on them now.

And that, Johnny, is why you're going to be the strongest man in the world. *General Electric Company, Schenectady, N. Y.*

☆ ☆ ☆

The volume of General Electric war production is so high and the degree of secrecy required is so great that we cannot tell you about it now. When it can be told we believe that the story of industry's developments during the war years will make one of the most fascinating chapters in the history of industrial progress.

GENERAL ELECTRIC

STEAMBOAT ROUND THE BEND

(*Continued from page 40*)

erated. Unfortunately for Marestier's appreciation of the advantages of Evans' high-pressure engines, the boiler of the *Aetna* blew up in 1824, killing 12 people and scalding a number of others more or less seriously. This was the year in which the Fulton monopoly was ended by the Supreme Court.

It should not be imagined that the monopoly had been willingly accepted. In 1811, Captain Elihu Bunker, financed by Albany businessmen, built the *Hope* and the *Perseverance* to run on the Hudson in competition with Fulton's boats. Both vessels were very like Fulton's steamboats as to hulls and machinery, the latter having been constructed by Robert McQueen. There appears to be no reason why they should not have given good service, but action taken in the New York courts by Fulton led to their being turned over to his company and broken up.

The chain of circumstances and legal proceedings that finally ended the Fulton monopoly was commenced when Aaron Ogden, Governor of New Jersey, petitioned the New York Legislature to remove restrictions against the operation of his steamboat, the *Sea Horse*, between Elizabethtown, N. J., and New York City. This small side-wheeler, built by Ogden in 1811, was fitted with a beam engine constructed by Daniel Dod. In his *History of American Steam Navigation*, John H. Morrison states that this was the pioneer American marine beam engine. Ogden's petition was referred to a committee of the New York State Assembly, which reported favorably on it and recommended legislation terminating the monopoly. The recommendation was based on the findings of the committee that both Fulton and Ogden's steamboats were "in substance the invention of John Fitch, patented in 1791 to him, and after the expiration of his patent common to all citizens of the United States. . . ." The bill recommended by the committee was passed, with some changes, by the Assembly but failed to pass the Senate.

At this juncture, Fulton and Livingston, probably fearing the legal termination of their highly profitable monopoly, agreed to allow Ogden to operate his boat for 10 years under the terms of a permit issued by them. This quieted Ogden but not his former partner, Thomas Gibbons of Savannah, who carried on the fight by putting two steamboats, the *Stoudinger* and the *Bellona*, into service on the Elizabethtown–New York route in opposition to the *Sea Horse*, now running under the terms of the permit issued by Fulton. Ogden then applied to legal authorities of the state of New York for an injunction prohibiting Gibbons from running his vessels in New York waters. The resulting litigation was finally taken to the United States Supreme Court, but long before reaching that tribunal it was the indirect cause of Fulton's death. He died in February, 1815, after an illness resulting from exposure to severe weather on New York Bay as he returned from

(*Continued on page 44*)

"One Air Conditioning System, Please"

AN INDUSTRIAL Air Conditioning System consists of the equipment of many manufacturers, interconnected to function as a unit. The best equipment can fail to maintain the conditions desired unless it has been carefully selected for load balance and installed with an understanding of its performance at other than maximum capacity.

For years the men in our organization have maintained an independent engineering approach to the problems of installing air conditioning. Their experience has proved that standard equipment can be selected from reputable manufacturers that will best meet the requirements of your particular air conditioning needs without compromise.

In coöperation with your production engineers, we will select your equipment and install your system to give you maximum productive efficiency.

We perform all the work necessary to obtain this objective — whether ordinary temperature control — or a complicated substratospheric-tropic chamber — thus reducing your problem to the simple request: — "ONE AIR CONDITIONING SYSTEM, PLEASE!"

HAROLD J. RYAN, INC.

101 Park Avenue, New York City

COMMUNICATIONS
...directing arm of combat

This battle drawing was prepared with the aid of Army and Navy authorities.

IN modern battle, our fighting units may be many miles apart. Yet every unit, every movement, is closely knit into the whole scheme of combat—through communications.

Today much of this equipment is made by Western Electric, for 60 years manufacturer for the Bell System.

Here are some examples of communications in action.

1 Field H.Q. guides the action through field telephones, teletypewriters, switchboards, wire, cable, radio. Back of it is G. H. Q., directing the larger strategy... also through electrical communications. The Signal Corps supplies and maintains all of this equipment.

2 Air commander radios his squadron to bomb enemy beyond river.

3 On these transports, the command rings out over battle announcing system, "Away landing force!"

4 Swift PT boats get orders flashed by radio to torpedo enemy cruiser.

5 From observation post goes the telephone message to artillery, "Last of enemy tanks about to withdraw across bridge..."

6 Artillery officer telephones in reply, "Battery will lay a 5 minute concentration on bridge."

7 Tanks, followed by troops in personnel carriers, speed toward right on a wide end-run to flank the enemy. They get their orders and keep in contact—by radio.

Western Electric
ARSENAL OF COMMUNICATIONS

BATH
IRON WORKS
CORPORATION

Shipbuilders and
Engineers

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BATH, MAINE

BOSTON INSULATED WIRE
B·I·W
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ELECTRIC CABLES
for AIRCRAFT

LIGHTING AND POWER CABLES
SHIELDING IGNITION CABLE
BONDING WIRE ANTENNA WIRE
INSTRUMENT WIRES AND CABLES

Manufactured in accordance with latest Army and Navy Specifications

Special multiple conductor cable made to order — designed for particular applications on instruments and apparatus

BOSTON INSULATED
WIRE AND CABLE COMPANY
BOSTON, MASSACHUSETTS

STEAMBOAT ROUND THE BEND

(*Continued from page 42*)

Trenton, where he had attended a session of the New Jersey Legislature, then participating actively in the monopoly controversy.

When the case of Gibbons *v.* Ogden finally reached the Supreme Court in February, 1824, it attracted nation-wide attention. Daniel Webster represented Gibbons and, in the opinion of the average citizen, free enterprise in a fight to the finish with vested interest. The decree of the court, presented by Chief Justice Marshall, was one of Webster's great popular triumphs. It ended the monopoly and threw open all the great inland waterways of the United States to inventors, engineers, and investors eager to develop the steamboat into the great common carrier of a lusty and growing young country.

The immediate effect of Webster's victory was to open the Hudson route between New York and Albany to steamboat owners who had for years waited to show the superiority of their vessels over those of the North River Company. The boats produced by the Stevens', father and son, at once came into great prominence. Because they not only designed and built steamboats and their machinery but also operated them, the Stevens' were able to obtain firsthand knowledge of the practical problems of the steamboatman as well as those of the naval architect and marine engineer. To their credit must be placed the feathering paddle wheel; the design and construction of hulls with hollow water lines, an innovation in which they anticipated by many years the designers of the Baltimore clippers and Scott Russell; the hogframe; the adaptation of the return tubular boiler and forced draft to marine uses; and the construction of paddle steamers with long guards and the location thereon of the boilers. In short, they may be credited with the conversion of the crude steamboats of the first two decades of the Nineteenth Century into the swift and comfortable vessels which plied our eastern rivers and, within a few years of the termination of the monopoly, were the envy of the maritime world.

In 1827, a mere three years after the monopoly was ended, Robert Stevens built the *North America* and fitted her with a pair of beam engines having cylinders 44½ inches in diameter and a stroke of eight feet, which gave this remarkable steamboat a speed of between 15 and 16 statute miles an hour. (Steamboatmen did not reckon distances in nautical miles or speed in knots.) Later, in 1841, Robert Stevens and his nephew Francis B. Stevens invented the Stevens cutoff valve gear, which greatly increased the efficiency of the beam engine. Though the beam engine has been belittled, it undoubtedly made possible such steamboats as the world-famous *Mary Powell* and the swift *Providence* and *Bristol* of the Fall River Line, with their huge single-cylinder engines of 110-inch bore and 12-foot stroke. In subsequent Fall River boats of iron and steel, the beam engine was abandoned in favor of inclined compound and triple-expansion engines, a decision that was no doubt wise when made. Yet it is a question whether the modern type of engine would have been a complete success in the more flexible hulls of early large

(*Continued on page 46*)

Wartime readjustments . . . #1

THE EASBYS ENJOYED ALL THE DISCOMFORTS OF VACATION — RIGHT IN THEIR OWN BACK YARD

WAR calls for all kinds of family adjustments — some amusing, some not. But they *do* bring a new sense of values.

Most families are learning to know each other better—to live more simply — to do without little luxuries in order to take care of big necessities.

That usually means War Bonds *first* — then life insurance. Both are certain investments in an uncertain world. Both help check inflation. Both boost the war effort, for a good part of each insurance premium goes into Government securities.

Families *need* the protection of life insurance today more than ever before. No other purchase provides so *much* protection for so *few* dollars. Let one of our *Career Underwriters* show you how New England Mutual's contract helps to finance itself through times when premium payments may be more difficult than usual.

Here are some of the advantages of a New England Mutual contract

1. **DIVIDENDS** begin at the end of the *first* year.
2. **CASH VALUES** begin at the end of the *second* year.
3. **A PREMIUM LOAN** is available toward payment of the *second* annual premium.
4. **CONVERSION** to Retirement Income or higher premium plans requires the payment of difference in reserves only.

New England Mutual
Life Insurance Company of Boston

George Willard Smith, President *Agencies in Principal Cities Coast to Coast*
THE FIRST MUTUAL LIFE INSURANCE COMPANY CHARTERED IN AMERICA—1835

Here's help with your adjustments!

It's easy to agree that family readjustments must be made in time of war. *But it's not always so easy to make them as Mr. Williams' cartoons suggest.*

You can count on some real help, however, from any of the men listed below. They're alumni of your college and they talk your language. They are also trained representatives of the First Mutual Life Insurance Company Chartered in America.

Out of their experience you'll get *practical*, constructive suggestions. They'll help you make the most of your limited life insurance dollars — help you protect your present policies with premium loans if necessary.

Check your protection *now when you need it most.* If none of these men is near you, you can get similar service at the New England Mutual office in your city.

RAYMOND P. MILLER, '18
Salem

▪

ARTHUR C. KENISON, '19
Boston

▪

BLAYLOCK ATHERTON, '24
Nashua

We're making readjustments, too. With some 15% of our field force now in military service, we have real opportunities for able men in several cities.

If you're interested in a satisfying career where you can be your own boss — and if your draft status is reasonably assured — we'd like to talk things over. Or perhaps you have a friend who might appreciate the tip.

In either case, just write to Wm. Eugene Hays (Stanford '26), 501 Boylston Street, Boston, Mass., for information. There's no obligation, of course.

The Liquid Carbonic Corporation

3100 S. Kedzie Avenue, Chicago, Illinois
Branches in all principal cities

Peace time Products	War time Products
• Soda Fountain Equipment	• Parachute Flares
Soda Fountains	• Naval Ammunition Hoists
Luncheonette Service Units	• Bridge Pontoons
Ice Cream Cabinets	• 37 mm. Armor Piercing Shot
Kitchen Equipment	• Anti-aircraft Gun Bases
• Beverage Bottling Equipment	• Scullery Sinks
Bottle Washers	• Tank Turret Parts
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Pasteurizers	• Machine Gun Turrets,
Mixers and Labelers	Magazines and
Water Refrigerating Units	Ammunition Boxes
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AND

IN PEACE AND WAR

• Welding Equipment and Supplies
• Extracts and Syrups

• Commercial Gases	• Medical Gases
Carbon Dioxide (CO_2)	Ethylene, Oxygen, Helium
Oxygen	Helium-Oxygen Mixture
Acetylene	Oxygen-Carbon Dioxide
Hydrogen	Mixture
Nitrogen	Nitrous Oxide
• Dry Ice	Carbon Dioxide

Liquid

The
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IS STILL A CRAFT

STEAMBOAT ROUND THE BEND

(*Continued from page 44*)

wooden paddle-wheel steamboats. In them the machinery had to accommodate itself to appreciable deformations of the hull without the development of bearing troubles and without derangement of the valve gear.

Though the Stevens family were the largest contributors to the development of eastern river steamboats, other individuals and organizations made important additions thereto. In 1825, James P. Allaire built compound engines for the *Henry Eckford* and subsequently designed and constructed similar engines for other steamers. Not until 44 years later did the compound engine make its appearance in the Atlantic service on the National liner *Holland*. Erastus W. Smith introduced the compound engine to the Great Lakes when, in 1850, he and John Baird designed a compound beam engine for the *Buckeye State*. The Allaire Works built this unusual engine, the high-pressure cylinder of which was inside the annular low-pressure cylinder, their diameters being respectively 37 and 80 inches and the stroke 11 feet. The steam pressure was 70 to 75 pounds a square inch.

Other prominent builders of machinery for eastern steamboats were the Novelty Works, established by the Rev. Eliphalet Nott of Schenectady, President of Union College, to build the engines for his anthracite-burning Hudson River steamboat *Novelty;* the Phoenix Foundry; the West Point Foundry; Hogg and Delamater; the Morgan Iron Works; Harlan and Hollingsworth; John Roach's Etna Iron Works; and a number of smaller firms along the northeastern seaboard. Most of these firms were located in or near New York, but they built and shipped marine engines all over the world, even to China, where their engines were used on Yangtze River steamboats of the American type.

A letter written to the home office of the Morgan Iron Works in 1889 by an erecting engineer who was installing an engine in a wooden steamboat in Bath, Maine, throws some interesting side lights on the practice of the day. It reads:

FRIEND RODMAN

As I promised before you left I have this morning taken measurements which I have put on sketch on other side which I hope you will understand so that there will be no mistakes from my Measurements. Flanges for Circulating Pumps you have the sizes at the Shop and would like to have them as soon as convenient so I can finish the pipes on pump. I shipped Templates and measuring Sticks for side pipe last night and saw the box leave the express office so you will have them as soon as you receive this letter. Please report to Mr. Need that I have twenty-one dollars left after paying board and money to men I also payed truckman there is nothing unpaid but 5 Galls Lard oil and 5 Lbs. Tallow. When any one comes from N. Y. I hope to have them stay over Sunday, not to run off Saterday night and leave me to drag over the longest day in the week alone.

Use of the term "side pipe" indicates that the engine under discussion was for a paddle steamer; furthermore, it was probably a beam engine.

(*Continued on page 48*)

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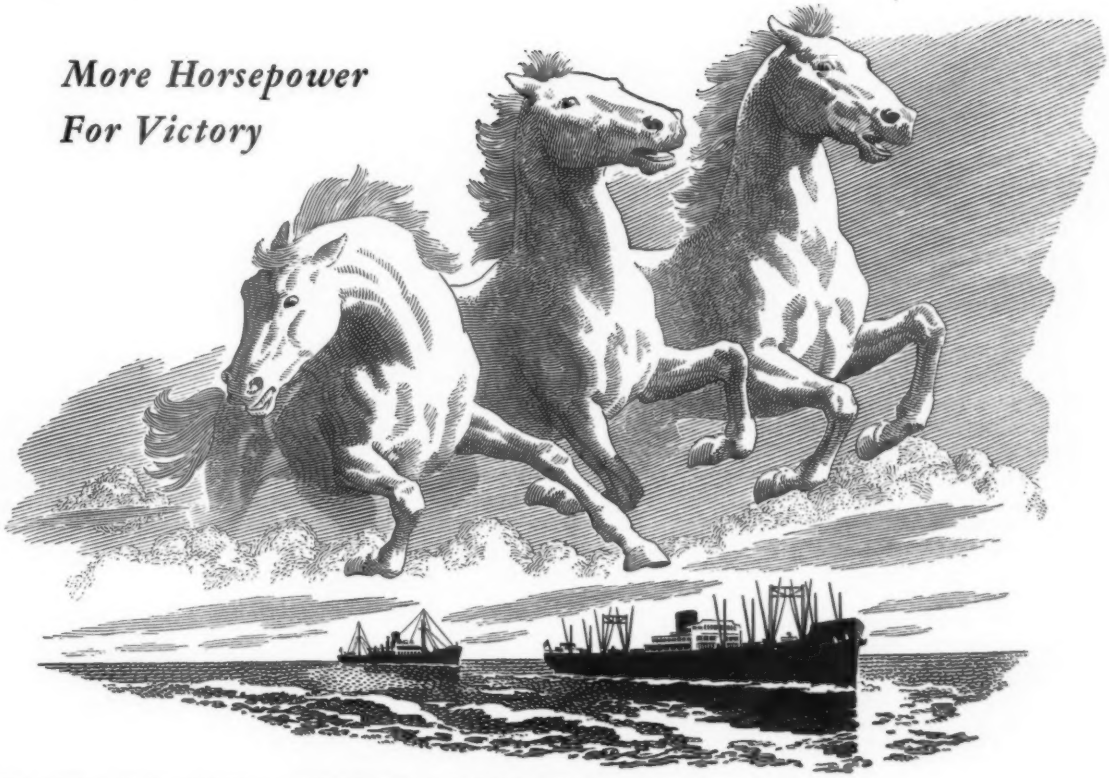

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STEAMBOAT ROUND THE BEND

(*Continued from page 46*)

From its earliest days, the screw propeller was widely used to drive freighters. But for reasons difficult to deduce, screw propulsion was not until recent years popular with the builders and owners of American river and sound steamboats designed for passenger service. To this general rule notable exceptions have occurred, such as the boats of the lower Chesapeake, steamers of the Lower Bay of New York Harbor, and the Long Island Sound steamers *City of Lowell, Richard Peck, Yale,* and *Harvard.* The two latter boats were remarkably fast turbine-driven steel vessels that ran for a time between New York and Boston and ended their days on the Pacific Coast in service between San Francisco and San Diego. Somewhat similar but smaller turbine-driven boats ran for a number of years along the New England Coast and on the Penobscot between Boston and Bangor.

The hulls of the majority of American steamboats of the great "steamboat days" of the country were wood, but an iron steamboat, the catamaran ferry *Siamese,* was built in 1838 for use on Lake Pontchartrain and the canal to New Orleans, seven years before the first iron ship was constructed for service on the Atlantic but not before small iron steamers had been built in Great Britain. Robert Stevens was a pioneer builder of iron steamboats, realizing at an early date that an iron hull was far preferable to one of wood in that it would be lighter, would be more durable, and would keep its shape better — characteristics which would promote satisfactory service and speed.

For about the first 70 years of practical steam navigation, our river and sound steamboats were without question the fastest vessels in the world, and it is unfortunate that obvious exaggerations of their speed have cast doubt on their actual performance. Discounting short runs over a measured mile, which may be made at speeds considerably in excess of the highest sustained speed of which a steamer is capable, Morrison gives documented evidence that by 1850 there were Hudson River and Long Island Sound steamboats capable of 20 statute miles an hour and that by 1865 the figure had risen to about 23 miles an hour, a figure that has not been exceeded in eastern waters except by the turbine-driven *Harvard* and *Yale* of the present century. Before the passage of the steamboat inspection law in 1852, much informal spectacular steamboat racing took place on the Hudson with, very naturally, some deplorable accidents. A few formal match races also attracted wide attention.

After the inspection service became effective, our eastern steamboats were more conservatively and safely operated, but for years they shared with western river steamboats the honor of being the swiftest vessels afloat. The fastest steamboats of the Mississippi were nearly if not fully as fast as those of our eastern waters. They differed widely in both hull types and machinery, however, and their development was almost completely independent. The history of the western steamboats is, therefore, another story.

(*To be concluded*)

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TRANSMITTING, BENDING

(*Continued from page 30*)

The Pulfrich refractometer, which also measures the angle of total reflection, will give index readings accurate to a few units in the fifth decimal place and *nu* values to an accuracy better than ±0.2. In order to obtain results of this accuracy, careful attention to calibration and manipulation is required. The sample must be polished accurately flat and must have a small end surface at right angles to the flat polished surface.

The fundamental method for measurement of index and dispersion makes use of an accurately polished and measured prism used with a high-grade spectrometer. For the greatest accuracy, an interference method has been used.

Obviously, the index of refraction of glass was not important or known until the science of optics came into being. Its importance grew with that science, and eventually consideration had to be given to the relations between light of different colors and index of refraction. Since all glasses have different refractive powers for light of different colors, a sharp image cannot be formed with a single lens. A series of overlapping colored images is formed. This phenomenon is known as chromatic aberration. To reduce it, glasses of high index and low dispersions can be combined into composite lenses, known as achromatic lenses. But the extent to which this correction could be applied was soon found to be limited. In general, the early lenses were made from crown glass, index about 1.5 and *nu* value about 58. Later such crown glasses were combined with glass containing lead, known as flint glass and having an index of about 1.6 and *nu* value of 36. Use of barium compounds in place of lead made it possible to obtain glasses with indexes of 1.55 to 1.66 and *nu* values from 50 to 55, which in composite lenses with other glasses gave much larger optical fields, well corrected in all respects.

The availability of glasses covering a wide range of indexes and dispersions was of much value to the science of optical design. Often their availability made it practical for lens design to be based on them. Sometimes lenses were designed without regard to the available glasses, and compositions were tailored, as far as possible, to fit the design. At present, glasses possessing a great variety of optical properties may be had. With the growth of optical design, glasses which differ but little in refractive properties may each have a place in eliminating or reducing certain residual aberrations in complex lens systems. Zinc, phosphorus, boron, titanium, aluminum, and antimony are among the elements used in addition to the usual silicate glasses containing lead or barium.

In recent years numerous investigations have been made of nonsilicate glasses. Leon W. Eberlin and George W. Morey produced glasses with a wide range of indexes, up to 2.08 in compositions containing no silica. The glass-forming constituents comprise lanthanum, zirconium, titanium, tantalum, boron, lithium, and sodium.

Phosphate glasses have been of interest for a long time. The difficulty has been to get them stable to moisture. Glass technologists have succeeded in making glasses containing 75 per cent of phosphorus pentoxide

which are less water-soluble than plate glass and which have indexes of about 1.52 and *nu* values of 75. In addition, the ultraviolet transmission far exceeds that of usual glasses.

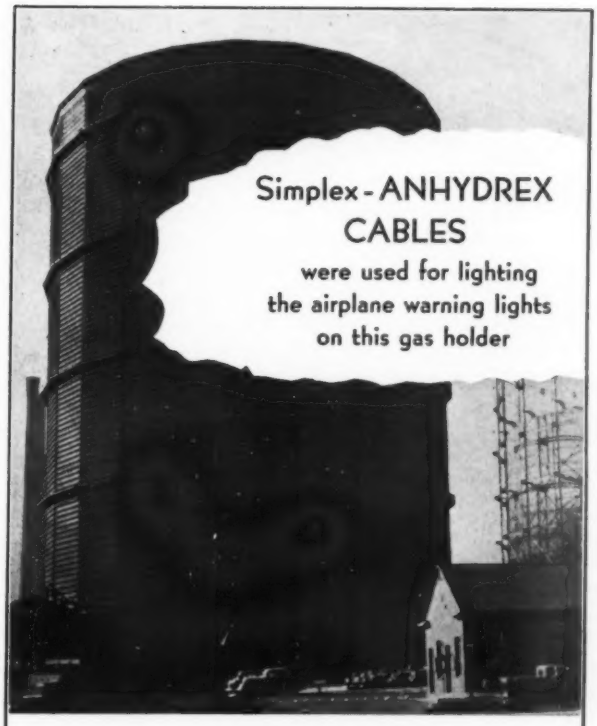
Glass composed of zinc borate, with a few stabilizing ingredients, has an index of 1.65 and a *nu* value of 50 to 55. Cadmium borate glass has an index as high as 1.70 with a *nu* value of 52.

Another property of glass which may be termed "optical" is its reflectivity. This depends upon a sharp transition in index between the glass and the surrounding medium. When the surrounding medium is air, the reflection may be objectionable, especially with complicated lens systems. In photography, undesired reflections cause false images that are reproduced on the film or result in a general fogging of the film, which reduces contrast and masks detail. The loss by reflection at each of the glass-air surfaces reduces the amount of light passing through the lens system and makes longer exposures necessary.

The efficiency of reflection elimination has lately been increased by the application of single or multiple layers of the correct indexes and thicknesses to reduce reflection, together with its attendant difficulties, to a very low value. Camera-projector lenses thus treated are now commercially available. Since these films, or layers, are about 1/200,000-inch thick, the influence of very small quantities on optical properties may be appreciated.

Certain natural and synthetic crystals are still used in optical systems because as yet no glasses exist which can replace them. Fluorite and quartz are used, especially in combination, for their ability to transmit radiation outside the visible; they make a lens apochromatic in the ultraviolet and the visible regions. Fluorite, rock salt, and other alkali halides are used in infrared spectroscopy. Synthetic crystals, artificially grown from melted salts, are becoming very useful. Lithium fluoride has many of the desirable properties of fluorite (calcium fluoride) and is now available commercially. Large alkali halide crystals are also produced by the same general method.

It is difficult to predict just what further advances may be made in glass from an optical point of view. New methods of melting — as in porous refractories lined with platinum foil, or possibly by electric heating or electron bombardment *in vacuo*, combined with supersonic vibration to prevent segregation and bubbles — may help to give us glasses now undreamed of. Melting, shaping, heat-treating, extracting, and sintering, as used in making the new superpyrex, may enable us to produce desirable optical glasses capable of being made in no other way. Perhaps instead of being dependent on melting alone, glasses will be made by chemical reaction and precipitation at room temperatures, followed by melting, to bring about the chemical reactions between the ingredients of the glass batch. The chemical stabilization of existing glasses, notably those containing lead or barium, suggests that many potentially useful glasses, abandoned because of their lack of stability, may likewise be modified. Major advances in silicate glasses may be limited by factors of immiscibility and devitrification, but thoroughgoing investigation of other types should yield rich rewards and prove of great aid to the optical world.



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THE INSTITUTE GAZETTE

(*Continued from page 35*)

Ralph Adams Cram, 1863–1942

RALPH ADAMS CRAM, the distinguished architect who from 1914 to 1919 was senior professor of the Department of Architecture, died in Boston on September 22. Of his many architectural monuments, the most imposing is the Cathedral of St. John the Divine, of which he was the architect from 1911 until recently. He died at the age of 78, having lived to see the great cathedral virtually completed and to stand under the magnificent rose window at the west door and look through the long nave, the crossing, and the choir to the high altar more than 500 feet away. St. John the Divine is the largest church in the Western Hemisphere and second in the world only to St. Peter's in Rome. "My idea of the cathedral," Mr. Cram once said, "is that it will be a great showing forth of the basic fact that religion is of the very essence of human life and that any community that disregards it will disintegrate and any civilization that follows the same course will perish."

A famous authority on Gothic architecture, an idealist unafraid to speak his thoughts on many subjects outside his profession, Ralph Adams Cram precipitated a large number of controversies. His views on politics were positive, and he advocated with enthusiasm and eloquence a nonpartisan democracy which he defined as equality of opportunity and the abolition of privilege.

As supervising architect for Princeton University, Mr. Cram is represented by many of the university's finest buildings, including the great Cleveland tower. He supervised the rebuilding of the United States Military Academy at West Point, and his genius in Gothic architecture may be recognized in many churches in this country and in Canada. He was also the architect for Rice Institute, for the commencement hall and a group of dormitories at Williams, for the library at the Taft School, and for two buildings at Phillips Exeter.

(*Concluded on page 54*)

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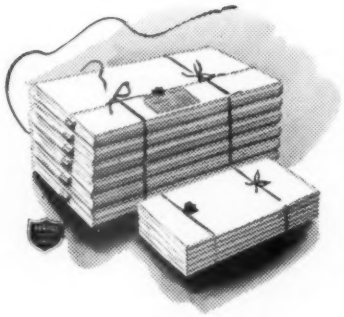

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THE INSTITUTE GAZETTE

(*Concluded from page 52*)

His association with the Institute as senior professor in the Department of Architecture included a lively interest in the ceremonies that attended the moving of the Institute from Boston to Cambridge: He was chief marshal of the great pageant, the Masque of Power, which symbolized the beginning of a new era in technological education; he designed the ceremonial barge *Bucentaur* and played a leading role in the dedication pageant.

Mr. Cram held honorary degrees from the universities of Princeton, Yale, and Notre Dame, and from Williams and Rollins colleges.

Registration

CHANGE of but 17 students to a total of 3,020, or a decrease of less than half of 1 per cent from the 1941–1942 total of 3,037, was recorded in registration figures at the Institute for the academic year of 1942–1943. Comparisons are made between figures for the third day of the present term and those for the third day of the fall term of 1941. Freshman, sophomore, and junior classes showed gains in enrollment over last year of 85, 44, and 19 students respectively. Senior and graduate registrations dropped 79 and 86 respectively.

MAIL RETURNS

(*Concluded from page 8*)

the population which contribute to the attainment of axis war aims. Free diffusion of such information on a humanitarian basis does us only harm, without a compensating benefit to dominated peoples for whom we rightly feel sympathy. For somewhat different reasons Germany even suppressed statistics of disease in axis and occupied areas. Here they probably fear quite as much the effect of full knowledge on the home front as the comfort which we might derive.

The other side of the shield is the rather naïve assumption of the technical data license division that it is legitimate to publish in this country what cannot be sent in print even to our own territories. There is certainly no guarantee that the United States is hermetically sealed so that information can reach our enemies only if it is first exported, by permission, beyond the United States. While one may still hold that the necessary censorship can remain largely voluntary, it must be intelligent rather than bound to the letter of rules and must take into account the well-known character of our enemies.

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Below—Better practice: even loading, return belt well protected.

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1. Make sure idlers are in good condition, turn freely and are so lubricated that oil and grease will not get on belt.
2. Avoid long feeding drops for heavy materials. Install retarding devices or redesign feed chutes.
3. Load evenly and centrally to distribute wear over entire surface. Irregular, uneven or heavy loading causes spillage, tends to make belt run crooked.
4. Hard pieces of material passing between tail pulley and belt will damage belt. Install tight decking over return belt, especially at feed point.
5. Load to capacity, but don't overload nor overspeed. Regulate speed to prevent cover wear. Empty belt before stopping.
6. Don't use guide idlers. Crooked running belts should be cut and accurately respliced, idlers aligned and the feed made central.
7. Use lagging on drive pulley to reduce belt tension.
8. Slide, don't drop, material on belt, through a notched opening or over a coarse screen or grating in chute so fines will cushion the lumps. Don't let lip of chute touch belt.
9. Keep belts and pulleys clean.

Thomas H. Boyd,'23 Wilder E. Perkins,'25 Charles P. McHugh,'26
Daniel J. Hanlon,'37 Albert W. Beucker,'40

10. Keep end pulleys and idlers in alignment to prevent belts running crooked.
11. House belts to protect them from sunlight, excessive heat, cold and moisture, and to make repairs and inspections easier.
12. Inspect belts and idlers regularly and make necessary belt and splice repairs promptly. Keep belt tension low.
13. On belts under high tension use vulcanized field splices. When metal fasteners are used select correct size for the end pulleys.
14. Gravity take-ups, mechanical feeders, large end pulleys and careful, frequent inspection and maintenance prolong the life of conveyor belts.
15. Consult your MANHATTAN service man.

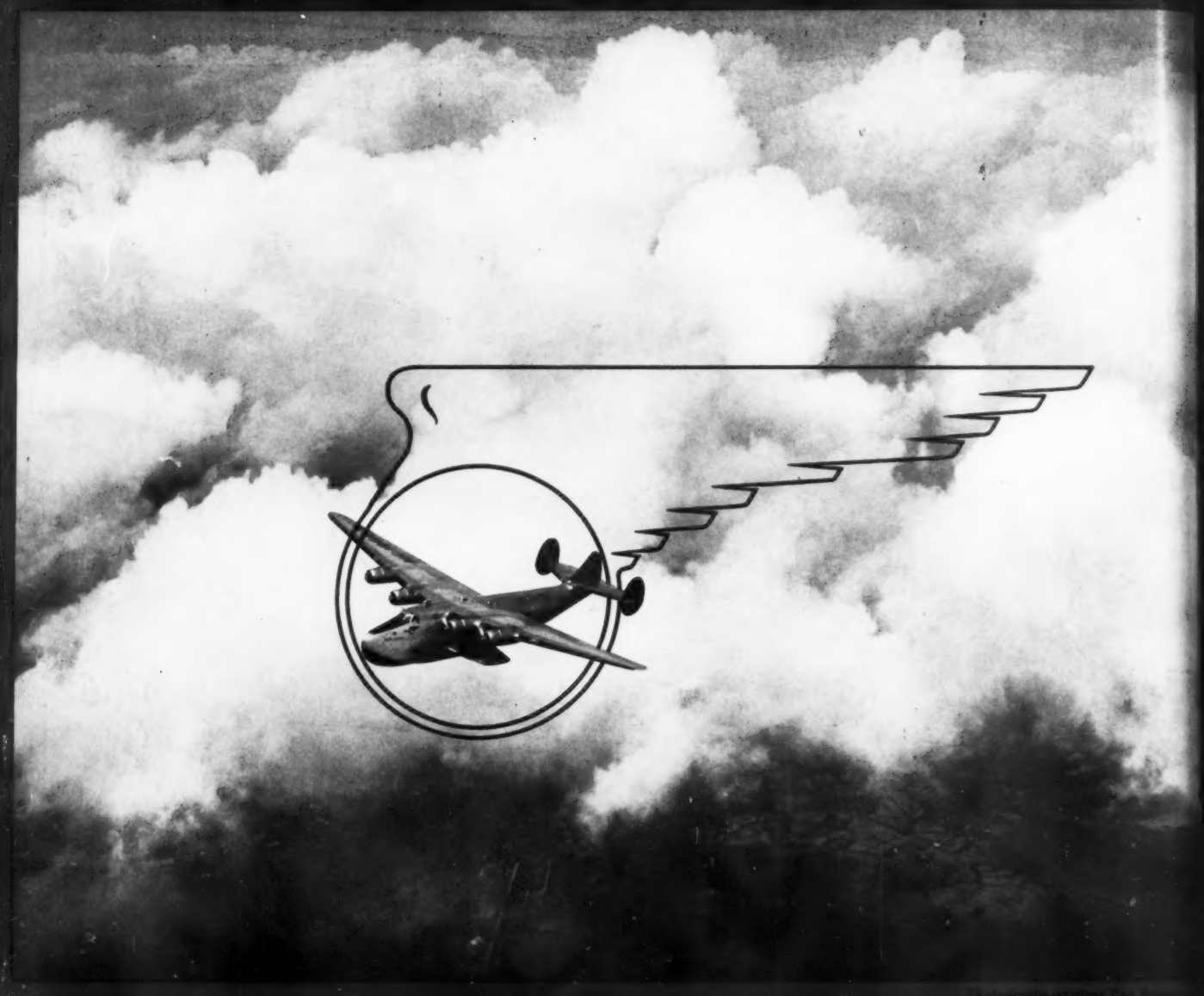
Copies of these instructions are available on wall cards for your maintenance department (also on the care of Transmission Belts, V-Belts and Hose). Write for any you want and wage war on wear.

KEEP AHEAD WITH

THROW YOUR SCRAP INTO THE FIGHT!

MANHATTAN

THE MANHATTAN RUBBER MANUFACTURING DIVISION
of RAYBESTOS-MANHATTAN, INC.
EXECUTIVE OFFICES PASSAIC, NEW JERSEY

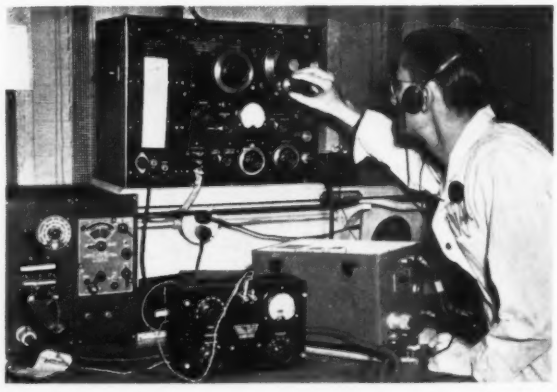


Dependable Service

The maintenance of *all* types of radio communication systems requires accurate and reliable test equipment. The General Radio Company has always specialized in the design and manufacture of this type of equipment.

The accuracy and rugged construction of General Radio instruments have won for them particularly wide acceptance among airlines — including the world-wide Pan American Airways System — to whom reliable radio communication is vitally important. Wartime conditions have given the airlines an urgent and difficult transportation job, which means that test equipment must often be used "around the clock." General Radio instruments are built to stand up under these unusual demands.

General Radio standard-signal generator and output meter in use in the radio test and repair shop at Pan American Airways' hangar at LaGuardia Field.



GENERAL RADIO COMPANY · Cambridge, Massachusetts